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STENOTELEGRAPHY.

RAPIDITY of communication is undoubtedly one of the greatest necessities of our epoch. When any important event occurs in any place whatever, it is immediately signaled in every direction; it is for any one to first make the news known. In this order of ideas the telegraph is daily rendering great services. Every one will agree with us, however, that the performance of the most improved apparatus is relatively very limited, and that the cost of transmission is very high. It is with press dispatches that these two inconveniences make themselves particularly felt.

Mr. Cassagnes' stenotelegraph, which we propose to give a brief description of, is designed to remedy, in a large measure, the inconveniences just mentioned.

As its name indicates, this new apparatus transmits with the rapidity of speech and transcribes the stenograph at a distance by the processes of multiple telegraphy. We may add that the stenograph obtained is printed upon a paper band in typographical characters that any one can read.

The stenotelegraph consists essentially of a transmitter and a receiver (Figs. 1 and 2). In the case of a short distance of one or two miles, in the same city, for example, the transmitter and receiver are connected by a cable of twenty wires. In long distances, between two cities, for example, the transmission and transcription are effected by means of the same apparatus connected by a single ordinary telegraph wire. In the latter case, a few intermediate apparatus of which we shall speak are used in the transmitting.

We shall now examine in succession the various elements of the whole affair. As a transmitter, Mr. Cassagnes employs the keyboard of the Michela stenographic apparatus, about which it is well to say a few words in order that what follows may be understood. The Michela keyboard comprises twenty piano keys, each actuating, through the intermedium of a horizontal lever, a vertical rod carrying a conventional character at one of its extremities. The vertical rods, twenty in number, one for each key, are united under a band of paper 1⅛ inch in width, upon which they print the signs corresponding to the depressed keys, as shown in Fig. 4.*

Things are so arranged that a line represents a syllable formed as follows: One of the first six keys to the left of the keyboard, or a combination of two or three keys, gives the first consonant of the syllable; the four following keys give the second consonant; the four others give the vowel; finally, the last six keys give the last consonant of the syllable.

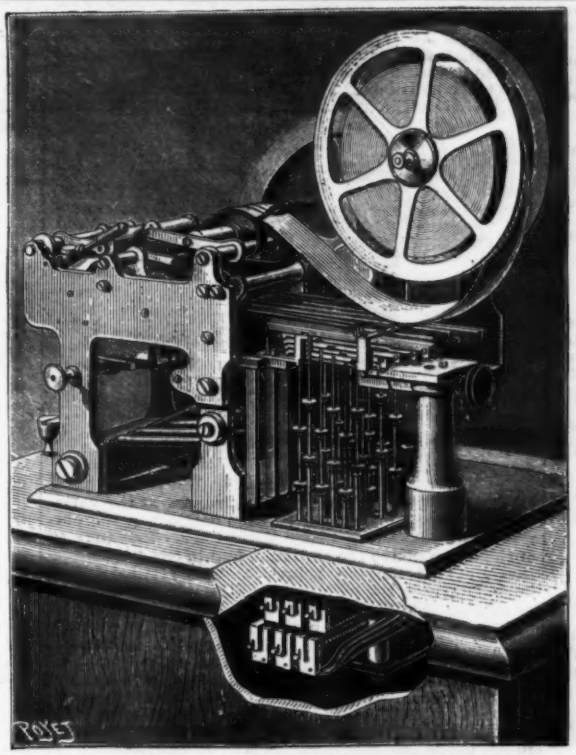


FIG. 1.—RECEIVING AND PRINTING APPARATUS OF THE STENOTELEGRAPH.

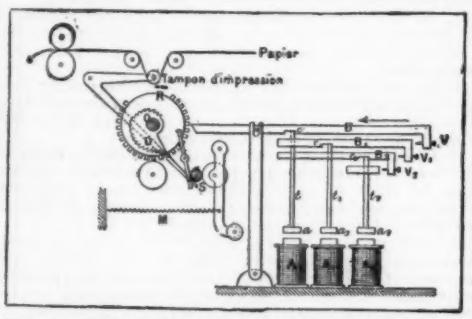


FIG. 2.—DIAGRAM OF THE MECHANISM OF THE RECEIVER.

The manipulations of this apparatus, employed by the Italian Senate, is extremely simple. The words pronounced by an orator are decompounded by the stenographer, which prints them syllable by syllable upon the band of paper with the rapidity of speech.

It is the Michela keyboard and alphabet that Mr. Cassagnes employs, with the difference that in the stenotelegraph the object of depressing the keys is simply to close an electric circuit, which acts, as we shall explain, upon the receiving apparatus. On another hand, as we have already said, the Michela combinations of signs produced in the transmitter are transformed in the receiver in such a way as not to furnish conventional signs, but the corresponding typographic letters.

The receiver, a general view of which is given in Fig. 1, is explained in Fig. 2. It consists essentially of the following parts: (1) Twenty electro-magnets, A, each connected, through a wire of the cable (in case of a transmission to a short distance) with a key of the keyboard. These electros are arranged in four groups of 6, 4, 4, and 6, corresponding to the groups of keys of which we have above spoken.

(2) Twenty horizontal slide bars, B, arranged above the electros, grouped themselves in four series. Each slide bar is normally held by a rod, *t*, forming part of the armature, *a*, of the corresponding electro, and which enters a notch, *e*, in the slide bar.

(3) Four type wheels, R, held by friction upon an arbor, O, opposite the four groups of slides. The first of these wheels carries 26 typographic characters upon its periphery, and prints the first consonant of the syllable. The following wheels carry respectively 11, 11, and 26 characters for the printing of the second consonant, the vowel and the last consonant of the syllable. Each wheel is combined with a toothed spiral, D, which carries a number of teeth equal to the number of the types of the corresponding wheel.

The operation of this entire affair is as follows:

When, in transmitting, a key is depressed, the circuit of the corresponding electro (A, for example) of the receiver is closed; the armature, *a*, is attracted, and, with it, the rod, *t*, which frees the slide bar, B. This latter, under the action of a spiral spring, M, moves in the direction shown by the arrow. The screw, V, then abuts against the right extremity of the slide bar, B', and the left extremity of the first, B, is arrested at a definite distance in advance of the axis, O. If, at the same time, we free the arbor, O, which is revolved by a small electric motor, the type wheel will be carried along. The one situated opposite the slide bar, B, will be stopped when the tooth of the spiral, D, which is at the same distance from the axis of rotation, O, as the extremity of the slide bar, abuts against the latter.

The apparatus is so regulated that at the moment of stoppage, the corresponding letter in the advancement of the slide bar is beneath the impression cushion. Suppose, now, that in order to obtain a letter, we must depress, for example, two keys that close the circuit of the electros, A and A'. It is easily seen that the slide bar, B, advancing toward the left to a distance regulated by the screw, V_1, the arrest of the screw, V, will be retarded to an equal degree. The displacement of the first slide bar, B, is therefore the sum of the individual displacements of the two slide bars considered. The tooth of the spiral arrested corresponds in this case to the combination of the two keys depressed. The receiver is completed by a few arrangements of detail. Thus, a series of cams, S, produce the impression, the advance of the paper, and the recoil to the right of the slide bars, B, which the rods, *t*, hold anew in their initial position.

What we have just said in regard to one of the type wheels is applicable to all the others, and the printing of the syllables is effected as shown in Fig. 5, which reproduces a stenographic translation of the conventional signs in Fig. 4.

As may be seen, the bands obtained are perfectly legible. They can be used by compositors either without being written out, or be revised by a corrector.

From the standpoint of stenography, properly so called, this apparatus, which permits of the transmission of two hundred words per minute, offers serious advantages over stenography by hand, by reducing the time necessary for transcription.

Let us now examine the case of transmission to a great distance. As in all multiple transmission telegraphs, a distributer is used in this case, the principle of which we shall make known. Let us suppose a copper circle, D (Fig. 3), divided into a certain number of sectors isolated from each other, over which moves the extremity of a rubber, F, mounted upon the axis of a Paul la Cour phonic wheel, A, and let us admit for an instant that the sectors, twenty in number, are each connected through a wire with the electros of the printing receiver. Finally, let us suppose that the two rubbers, F and F', connected by a wire of the line, L, turn at the same speed and pass at the same instant over the sectors of the same row.

If a key be depressed (the one numbered 4, for example), the current will pass into the line wire and will actuate the electro No. 4 when the rubbers pass over the sectors No. 4, and at that moment only.

The electromagnet attracts its armature, and the effects that we have before described in connection with the twenty-wire cable are here reproduced with a single wire. It will be understood, however, that for great distances, it is necessary to use, at a receiving station, relays, R, that close the circuit of a local current which actuates the electros of the receiver.

On another hand, in order that the transmission might be effected without loss of contacts, it would be necessary, in transmitting, for the keyboard to be actuated in cadence at the rate of one syllable per revolution of the rubber of their sending station. Now, such a condition cannot be realized, since the rapidity of manipulation of the keyboard is subordinated

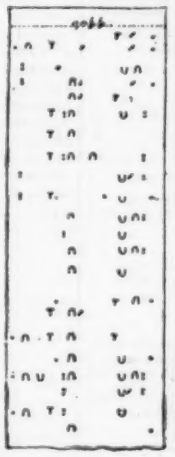


FIG. 4.

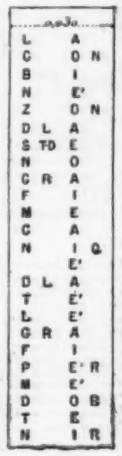


FIG. 5.

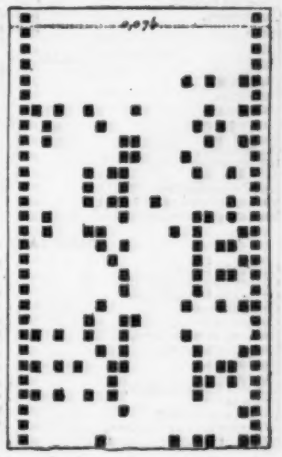


FIG. 6.

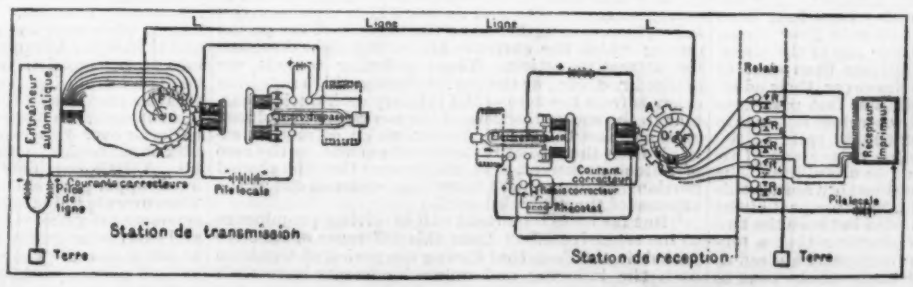


FIG. 3.—DIAGRAM OF TWO STATIONS IN COMMUNICATION.

* Translation: La combinaison de la stenographie mecanique et de la telegraphie, permet d'obtenir une rapidite de transmission inconnue jusqu'a ce jour.

to the rapidity of speech. In order to remedy this inconvenience, Mr. Cassagnes employs two small apparatus whose principle we shall describe.

Upon a transmission, the keyboard actuates a perforator, which consists essentially of twenty punches that act vertically upon a band of paper.

This latter on making its exit from the apparatus is therefore perforated with a series of square apertures at the place that would be occupied by the conventional signs, if printing were done.

The band thus obtained (Fig. 6) with the rapidity of speech is placed in another apparatus, which carries it along automatically, and by impulses, and makes it move forward by one line at a time. Twenty spring levers tend constantly to enter the apertures in the band in order to establish a series of contacts and close the circuits of the corresponding relays at the receiving station.

The paper, where it is not perforated, therefore forms an insulator. The motion of the apparatus that carries along the paper is regulated by the distributer of the transmitting station.

In practice, it is not with the keys (as we have above supposed, in order to make the system understood), but with the spring levers of the transmitting station that the sectors of the distributer of this station are connected.

The bands obtained at the other end of the line are identical with those represented in Fig. 5.

Fig. 3 gives the general arrangement of the two stations in the case of transmissions to great distances. The important point to remember is the necessity of the previous perforation and the use of perforated bands with the rapidity of speech for the sending of currents to the receiving station.

The theoretical performance of the apparatus is as follows :

For very great distances, from Paris to Marseilles, for example, the experiments made here demonstrated that it is possible to make use of distributers with two series of sectors. The rubbers making three revolutions per second, and the ratio of the stenographic lines to the words that they represent being about 80 to 100, it will be seen that on this distance it is possible to transmit $2 \times 3 \times 60 \times 0{\cdot}80 = 288$ words per minute.

For shorter distances, from Paris to Brussels, for example, distributers with three series of sectors may be used. The result in this case is $3 \times 3 \times 60 \times 0{\cdot}80 = 432$ words per minute.

We shall not dwell longer upon this high theoretical performance. We think the margin is sufficient to permit of a practical performance much greater than that of the most rapid telegraph, which gives from 25 to 30 words per minute at a maximum.

It is true that the telegraph transmits orthographized words, though this is not always necessary. The stenotelegraph also is naturally capable of transmitting in the same way, but with a diminution of thirty per cent. in the rendering.—*La Nature.*

WELDABLE BY ELECTRICITY.

Following is a list of the different materials which have been successfully welded together by the Thomson process, which may be of interest, inasmuch as the term welding is ordinarily used with especial reference to the joining of two pieces of material of the same or closely allied composition :

METALS.

Wrought iron,	Tin,	Aluminum,
Cast iron,	Zinc,	Silver,
Malleable iron,	Antimony,	Platinum,
Wrought copper,	Cobalt,	Gold (pure),
Cast copper,	Nickel,	Manganese,
Lead,	Bismuth,	Magnesium.

ALLOYS.

Stubs steel,	Fuse metal,
Cast brass,	Type metal,
Gun metal,	Coin silver,
Chrome steel,	Solder metal,
Mushet steel,	German silver,
Crescent steel,	Silicon bronze,
Bessemer steel,	Aluminum brass,
Steel castings,	Phosphor bronze,
Brass composition,	Aluminum bronze,
Various grades of tool steel,	Various grades of gold,
Various grades of mild steel,	Aluminum alloyed with iron.

COMBINATIONS.

Copper to brass,	Wrought iron to mild steel,
Copper to wrought iron,	Wrought iron to tool steel,
Copper to German silver,	Gold to German silver,
Copper to gold,	Gold to silver,
Copper to silver,	Gold to platinum,
Brass to wrought iron,	Silver to platinum,
Brass to cast iron,	Wrought iron to Mushet steel,
Tin to zinc,	Wrought iron to Stubs steel,
Tin to brass,	Wrought iron to Crescent steel,
Brass to German silver,	Wrought iron to cast brass,
Brass to tin,	Wrought iron to German silver,
Brass to mild steel,	Wrought iron to nickel,
Wrought iron to cast iron,	Tin to lead.
Wrought iron to cast steel,	

It will be seen from the foregoing that materials heretofore impossible to weld to pieces of similar composition have been welded, and not only this, but different combinations have been made, which are entirely impossible by ordinary methods.

Bronze Covered Propeller Blade.—A propeller blade consisting of a sheathing of bronze or delta metal cast on a steel core has recently been produced by Mr. John List, M. Inst. C.E., and Mr. Alexander Dick, of the Delta Metal Company, Limited. The advantages of bronze propeller blades have long been recognized. Such blades can be cast with finer edges, which will, moreover, last the whole life of the blade, and have a very much smoother surface than steel or cast iron blades. In spite of this, however, their adoption is still limited to war vessels and fast passenger steamships, as the ordinary shipowner does not care to face the heavy first cost of the bronze, in spite of the fact that it is worth a considerable percentage of its original cost as scrap at the end of its useful life. The new compound propeller will considerably reduce this first cost, as the steel core makes up a large part of the total weight of the blade. The union between the two metals is very perfect, actual test showing that a tensile stress of 15 tons per square inch was required to separate the metals. The new blade would seem to possess all the advantages of the bronze blades at a considerable reduction in the cost of these.

[Continued from Supplement, No. 762, page 12177.]

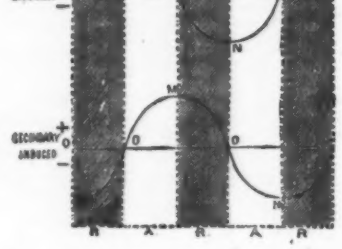
PROFESSOR ELIHU THOMSON'S ELECTRO-MAGNETIC INDUCTION EXPERIMENTS.*

By J. A. Fleming, M.A., D.Sc., M.I.E.E., Professor of Electrical Engineering in University College, London.

Returning for a moment to the theory of these repulsive and deflective actions, it will repay us to consider it in the form placed before us by Prof. Thomson, in his first paper on the subject, read before the American Institute of Electrical Engineers, May 18, 1887. He says: "It may be stated as certainly true that, were the induced currents in the closed conductor unaffected by any self-induction, the only phenomena exhibited would be alternate equal attractions and repulsions, because currents would be induced in opposite directions to that of the primary current when the latter current was changing from zero to maximum positive or negative current, so producing repulsion; and would be induced in the same direction when changing from maximum positive or negative value to zero, so producing attraction.

"This condition can be illustrated by a diagram, Fig. 22. Here the lines of zero current are the horizontal straight lines. The wavy lines represent the variations of current strength in each conductor, the current in one direction being indicated by that portion of the curve above the zero line, and in the other direction by that portion below it. The vertical dotted lines simply mark off corresponding portions of phase or succession of times.

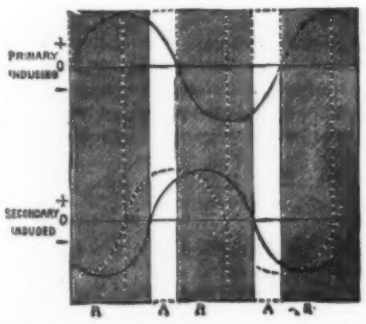
Fig. 22.



"Here it will be seen that in the positive primary current descending from M, its maximum, to the zero line, the secondary current has risen from its zero to M^1, its maximum. Attraction will therefore ensue, for the currents are in the same direction in the two conductors. When the primary current increases from zero to its negative maximum, N, the positive current in the secondary closed circuit will be decreasing from M^1, its positive maximum, to zero; but, as the currents are in opposite directions, repulsion will occur. These actions of attraction and repulsion will be reproduced continually, there being a repulsion, then an attraction, then a repulsion, and again an attraction, during one complete wave of the primary current. The letters, R, A, at the foot of the diagram, Fig. 22, indicate this succession. (The shaded portions in the diagrams represent the time during which the force between the primary and secondary circuits is a repulsive force.)

"In reality, however, the effects of self induction in causing a lag, shift, or retardation of phase in the secondary current will considerably modify the results, and especially so when the secondary conductor is constructed so as to give to such self-induction a large value. In other words, the maxima of the primary or inducing current will no longer be found coincident with the zero points of the secondary currents. The effect will be the same as if the line representing the wave of the secondary current in Fig. 22 had been shifted forward to a greater or less extent. This is indicated in diagram, Fig. 23. It gives, doubtless, an exaggerated view of the action, though from the effects of repulsion which I have produced I should say it is by no means an unrealizable condition.

Fig. 23.



"It will be noticed that the period during which the currents are opposite, and during which repulsion can take place, is lengthened at the expense of the period during which the currents are in the right direction for attractive action. These differing periods are marked *r*, *a*, etc., or the period during which repulsion exists is from the zero of the primary or inducing current to the succeeding zero of the secondary or induced current; and the period during which attraction exists is from the zero of the induced current to the zero of inducing current. (It will be seen that the shaded portions in diagram 23 have been widened out at the expense of the unshaded parts.)

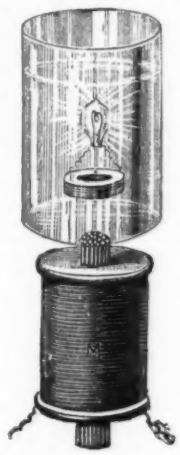
"But far more important still in giving prominence to the repulsive effect than this difference of effective period is the fact that during the period of repulsion both the inducing and induced currents have their greatest values, while during the period of attraction the currents are of small amounts comparatively. This condition may be otherwise expressed by saying that the period during which repulsion occurs includes all the maxima of current, while the period of attraction includes no maxima. There is then a repulsion due to the summative effects of strong opposite currents for a lengthened period against an attraction due to the summative effects of weak currents of the same direction during a shortened period, the resultant effect being a greatly preponderating repulsion.

"It is now not difficult to understand all the actions before described, as obtained with the varied relations of coils, magnetic fields, and closed circuits. It will be easily understood, also, that an alternating magnetic field is in all respects the same as an alternating current coil in producing repulsion on the closed conductor, because the repulsions between the two conductors are the result of magnetic repulsions arising from opposing fields produced by the coils when the currents are of opposite directions in them."

One of the most beautiful of Prof. Thomson's experiments illustrating this repulsion can, I think, be shown to you now.

An incandescent lamp is attached to the terminals of a coil of wire, and the coil and lamp floated in water or hung from a scale beam (Fig. 24) over the pole of an alternating magnet. The coil and lamp form, as it were, a balloon and car floating in space, and placed in a magnetic field. When that magnetic field is rapidly alternated by exciting the magnet, the induced currents created in the coil make themselves evident by illuminating the lamp, and the repulsive electrodynamic action shows itself by lifting the lamp and coil upward through the water or the air.

Fig. 24.



The same experiment renders it possible to show the effect of magnetic screening very prettily. If I introduce a plate of copper between the magnet pole and the induction coil attached to the lamp, the copper "screens" the coil from the inductive action of the pole, and the light of the lamp disappears. I must next direct your attention to some curious effects which are found to exist when two conducting circuits are exposed to the magnetic flux from an alternating magnetic pole, and which depend upon the interaction of the currents induced in each respectively. Professor Thomson embodies these facts now to be considered in four laws, which may be briefly stated as follows :

1. If two or more closed circuits are similarly affected inductively by an alternating magnetic field, they will attract one another, and tend to move into parallelism.

2. Iron or steel masses placed in an alternating field give rise to shifting magnetism or lines of force moving laterally, and may, therefore, act to move closed circuits in the path of such shifting lines.

3. Closed circuits in alternating magnetic fields or fields of varying intensity give rise to shifting magnetism, or lines of force moving laterally to their own direction, and may, therefore, act to move other closed circuits in the path of such lines.

4. Iron or steel masses may, when placed in an alternating magnetic field, interact with other such masses, or with closed electric circuits, so as to produce movement of such masses or circuits relatively, or give rise to tendencies to so move, the effects depending on continual adaptations of shifting magnetism and retained magnetism relatively.

It is a simple matter to illustrate these principles; and the experiments, which are designed so to do, bring before us some striking peculiarities of the action of magnetic force upon closed circuits, and upon masses of conducting and magnetizable matter.

Returning, first, to the simple experiment of a copper ring repelled by an alternating pole, we find that if we add a second ring under the first, they both attract one another, and the two rings are supported and repelled as if they were one ring. It is obvious that at any instant the induced currents in both rings are in the same direction, and hence they attract one another.

Such an attractive action can be made to produce continuous rotation. We have only to place a copper ring or plate over the alternating current coil or pole, and then bring a copper disk, free to revolve on pivots, into proper position relatively thereto. This can best be done by placing the ring or plate so as to be somewhat to one side of the pole, so as to "shade" part of it, as it were, while a part of the pivoted disk is placed under or over it, in front of the alternating pole. The disk then begins to revolve rapidly on its pivot (Fig. 25). A little consideration shows that in this case the fixed copper plate shields a portion of the pivoted plate. The currents induced in the fixed plate attract the nonsymmetrically placed induced currents in the other disk, and exert a tangential action or couple upon it tending to pull it round. The continual repetition of this action as each portion of the plate becomes in turn the seat of maximum inductive action results in a continual revolution of the plate. Two pivoted disks may be used in-

* A paper recently read before the Society of Arts, London.

stead of one, and it will be found that they may each "shade" a portion of the pole, and if made to overlap, they will pull each other round and revolve in opposite directions when the alternating pole acts upon them.

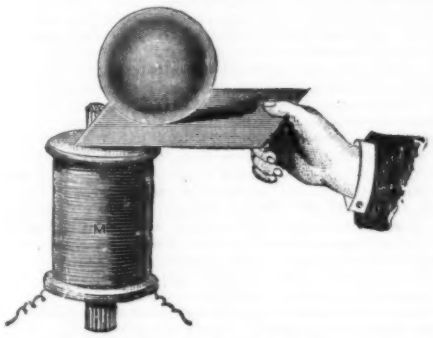
This principle of "shading" a portion of the magnetic pole, and hence causing an unsymmetrical distri-

FIG. 25.

bution of induced currents in a conducting body capable of revolution on a pivot, has been developed by Prof. Thomson in many extraordinary ways.

Floating, for instance, a hollow sphere of copper on the surface of water in a glass vessel, he places this over an alternating magnetic pole. If the pole is placed directly under the sphere, the electromagnet action would, as before explained, result in a repulsive force acting upon the disk. If, however, a sheet of copper is placed half over the pole so as to "shade" a portion of the copper sphere, the currents induced in it are unsymmetrically situated with respect to its center, and react upon the current induced in the plate. Hence, the electromagnet action resolves itself into a torque or couple, causing the ball to spin rapidly upon its center and take up a rapid rotation. So considerable is the rotational force brought to bear that the ball will rotate when merely laid on a sheet of copper, even overcoming the friction of such rotation on its equatorial line, provided that the ball and supporting plate are so held over an alternating pole that the plate shields a portion of the sphere (Fig. 26). Given this principle

FIG. 26.

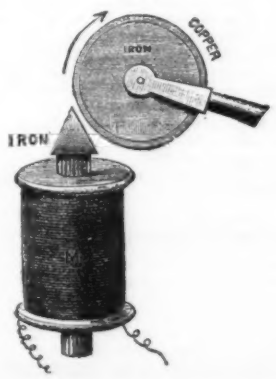


that by properly "shading" a pole from a portion of a solid body capable of revolution round a line or axis, it is easy to see that countless forms of electromotor can be designed.

A sort of anemometer with copper disks for cups, resembling the cross of a Crookes' radiometer, can be set in rapid rotation by an alternating pole, if a copper screen is placed so as to shade one side of it.

This unsymmetrical development of the induced currents can be produced by a suitable disposition of the magnetic pole alone. Thus we may place a cone or wedge of iron on the alternating pole, and hold near it a copper ring mounted so as to be able to revolve (Fig. 27). The copper cylinder or wheel revolves rapidly un-

FIG. 27.



der the action of the periodic field, and its direction of motion is such that it seems to be blown around by a blast from the end of the magnetic cone. Prof. Thomson has constructed a curious electrical gyroscope as follows: A vertical pivot projects from the center of an alternating pole (Fig. 28), upon which is pivoted a horizontal rod bearing a counterpoise, and a copper wheel, preferably with an iron core attached to it, gyroscope fashion, by means of a copper frame. The copper frame is placed in an inclined position with respect to the horizontal. Under these circumstances a vigorous rotation is communicated to the gyroscope wheel when the alternating field acts upon it. The copper frame shields one side of the wheel more than the other, and, as a result, the induced currents in the copper wheel are unsymmetrically placed with respect to its axes of rotation, and it experiences a violent torque.

These experiments can, by a little ingenuity, be endlessly multiplied when once the fundamental principle is grasped. Bodies can be made to rotate and move, taking their movements from the magnetized space in which they are placed, and without being supplied with current from an external source.

Prof. Thomson has, however, studied some curious cases of magnetic motion, in which rotations are obtained when iron or copper pivoted disks are placed

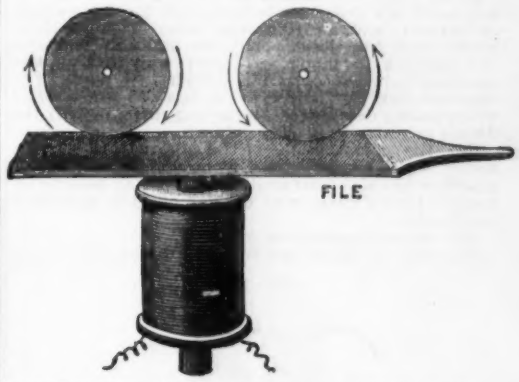
FIG. 28.

near to iron or steel bars, in which the propagation of magnetism is throttled by closed circuits. If a longitudinally laminated iron bar has a closed copper band or coil placed round it at one point, and if such a bar is made magnetic by a periodic current traversing a magnetizing coil embracing another part, this structure becomes capable of rotating iron or copper disks held near it. The explanation of this effect is probably to be found in the fact that the closed embracing coil tends to throw off the magnetic lines of force laterally at that point. Consider a bar (Fig. 29), A B, in which lines of magnetic force are being established in the direction from A to B. That is to say, let magnetic induction be increasing in the bar in a direction from A to B, at C let there be a closed coil embracing the bar, the magnetic induction during its period of increase is setting up in this circuit an electromotive force which establishes in the circuit a current whose lines of force are opposed to the primary induction inside the coil, and, therefore, in the iron included in the coil, but in the same direction outside the coil, and, therefore, outside the iron. The result is as if the lines of primary magnetic induction in the iron were shed off laterally and escaped round the coil. When the magnetic induction in the iron, due to the

FIG. 29.

magnetizing coil, is made periodic, this action will create a kind of lateral pulsation of the magnetic lines of force in the neighborhood of the closed coil. If, then, a movable conductor is held near such a magnetically throttled bar, it will be subjected to a displacement of lines of magnetic force through it laterally, and will hence have eddy electric currents generated up in it. These currents, persisting into the period of reversal of the field in virtue of self-induction in the conductor, will cause the portion of the conductor in which they are set up to be continuously repelled, and hence to take up a motion of rotation. A ring of cast iron, having a closed coil wound on it at one point, is held so that another point on its circumference, 90° removed from the closed coil, is on the pole of an alternating magnet. An iron disk, centrally pivoted and held concentric with the ring, is rotated when the magnet is energized by an alternating current. It is not even necessary to have a closed coil on one part of the active magnetic bar, provided that this bar is not laminated, or, better still, is made of hard steel. In these cases there is a lag in magnetization, due to either eddy currents set up in the bar or to hysteresis, and the result is a lateral escape of lines of force out of the bar. When it is held with one extremity on an alternating magnetic pole, there is in these cases an action which is a true "magnetic self-induction." In the case of electric circuits, if we join in parallel two circuits, one having very small ohmic resistance and very high self-induction, and the other very large ohmic resistance and small self-induction, a sudden flow of current chiefly selects the path of least self-induction for its flow during the variable period, although during its steady period it will chiefly flow by the path of smallest ohmic resistance; so in the case of a magnetic and conductive circuit of low magnetic and electric resistance (iron), shunted by a path of high magnetic and electric resistance (air), rapid variations of magnetic induction bring about a state of things in which the magnetic induction seems to chiefly select the path not of least but of greatest magnetic resistance during the variable period. Time will not permit me to develop at greater length the analogies of the magnetic and electric circuits under the conditions of rapidly periodic magnetic induction and electric current; but there are many suggestive ideas which arise when we place before our minds the notion of a magnetic self-induction which is the consequence of a time element coming into action in the setting up of induction in a magnetic and conductive circuit, and due to the production of electric eddy currents, just as the electro-magnetic or ordinary self-induction is the consequence of the time element coming into action in the setting up of an electric current, and due to the production of a surrounding magnetic field. Just as the rise of current strength under an impressed electromotive force, acting in a conducting circuit, is retarded by linking that conductive circuit with a magnetic circuit, so the rise of magnetic induction under an impressed magnetizing force acting on a magnetic circuit is retarded by linking that magnetic circuit with an electric conducting circuit. I am under the impression that Mr. Oliver Heaviside has developed these notions in a mathematical form, but am unable at the moment to place my hands upon the results. The effect, however, of a bar of unlaminated iron when surrounded by a magnetizing coil at one end, and traversed by a periodic current, is to cause rotation in copper or iron pivoted disks held near it, or when such a bar of non-laminated iron is abutted on the pole of an alternating magnet. A bar of steel, even if not laminated, is able to cause brisk rotations in copper or iron disks under the same circumstances. With hardened steel the action is more marked. Here the hysteresis retards the propagation of the magnetic wave. By laying a large file flatwise against the alternating magnet pole at about the middle of the file, disks of copper or iron may be kept revolving if held over those portions of the file which project from the pole of the magnet (Fig. 30). In this case the magnetic retardation

FIG. 30.



in the bar is brought about by its own physical structure, and not by embracing it with a closed conducting circuit. The result is, however, the same in kind; there is a sluggishness in the establishment of the magnetic induction on the steel or iron under the action of magnetizing force, which partly depends on the eddy currents in the mass of metal and partly on hysteresis. As a consequence, we have a periodic lateral displacement of the field. The question of a magnetic leakage dependent on a retardation of induction deserves special attention in the case of commercial alternate current transformers. Time will not permit me to enlarge on it here to any great extent; but I may observe that in the design of closed iron circuit transformers this magnetic leakage should not be neglected.

In a closed iron circuit embraced at one part by a magnetizing coil, and subjected to rapidly reversed magnetic force, the magnetic induction does not confine itself wholly to the path of least magnetic resistance, viz., the iron path, but takes a short circuit in part across the interior air space. This waste field may in badly designed transformers be something considerable. I believe that an important point to hold in view in transformer construction is to subject the iron circuit uniformly to the magnetizing force, by embracing all portions of the iron circuit with primary windings, and not locating the windings simply at one part. There is then a tendency to check the production of waste field by the lateral bulging out of the magnetic lines of force from the iron. In Fig. 31 is a

FIG. 31.

diagram illustrating the arrangement of primary and secondary coils most favorable for the production of waste field, and in Fig. 32 the arrangement least favorable for the same.

FIG. 32.

The foregoing experiments are of such a nature as obviously to force on us the thought that useful and perhaps important applications can be made in electromagnetic machinery. Professor Elihu Thomson has, as you can imagine, not been slow to do this; for in him is united both a keen scientific sagacity and that clear mental vision which enables him to pursue to its logical issue in practice the consequences of scientific discovery. He has already applied these principles to

the construction of alternating current indicators, alternating current arc lamps, regulating devices for alternating currents, and to rotary motors for such currents. For current indicators, a pivoted or suspended copper band or ring, composed of thin washers piled together and insulated from one another, and made to carry a pointer or index, has been placed in the axis of a coil conveying alternating currents, whose amount or potential is to be indicated. Gravity or a spring is used to bring the index to the zero of a divided scale, at which time the plane of the copper ring or band makes an angle of say 15 to 20 degrees with the plane of the coil. This angle is increased by deflection more or less great, according to the current traversing the coil. The instrument can be calibrated for set conditions of use. Time would not permit of a full description of these arrangements as made up to the present.

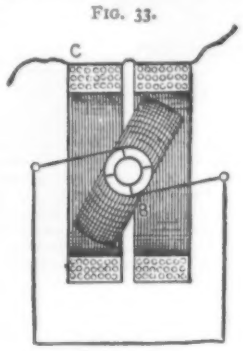
In arc lamps the magnet for forming the arc can be composed of a closed conductor, a coil for the passage of current, and an iron wire core. The repulsive action upon the closed conductor lifts and regulates the carbons in much the same way that electro-magnets do, when continuous currents are used. The electro-inductive repulsive action has also been applied to regulating devices for alternating currents, with the details of which I cannot now deal.

For the construction of an alternating current motor, which can be started from a state of rest, the principle has also been applied, and it may here be remarked that a number of designs of such motors is practicable.

One of the simplest is as follows:

The coils, C, Fig. 33, are traversed by an alternating

Fig. 33.

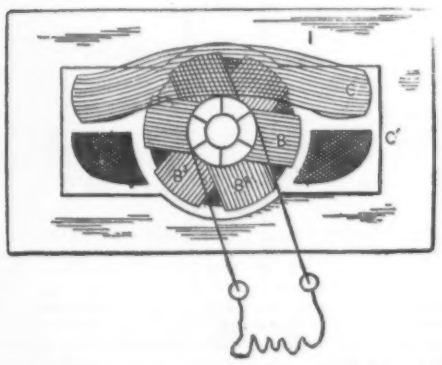


current, and are placed over a coil, B, mounted upon a horizontal axis transverse to the axis of the coil, C. The terminals of the coil, B, which is wound with insulated wire, are carried to the commutator, the brushes being connected by a wire, as indicated. The commutator is so constructed as to keep the coil, B, on short circuit from the position of coincidence with the plane of C to the position where the plane of B is at right angles to that of C; and to keep the coil, B, open-circuited from the right-angled position or thereabout to the position of parallel or coincident planes. The deflective repulsion exhibited by B will, when its circuit is completed by the commutator and brushes, as described, act to place its plane at right angles to that of C, but being then open-circuited, its momentum carries it to the position just past parallelism, at which moment it is again short-circuited, and so on. It is capable of very rapid rotation, but its energy is small.

He has extended the principle to the construction of more complete apparatus. One form has its revolving portion or armature composed of a number of sheet iron disks, wound as usual with three coils crossing near the shaft. The commutator is arranged to short-circuit each of these coils in succession, and twice in a revolution, and for a period of 90° of rotation each. The field coils surround the armature, and there is a laminated iron field structure completing the magnetic circuit.

In Figs. 34 and 35 we have diagrams which will give

Fig. 34.

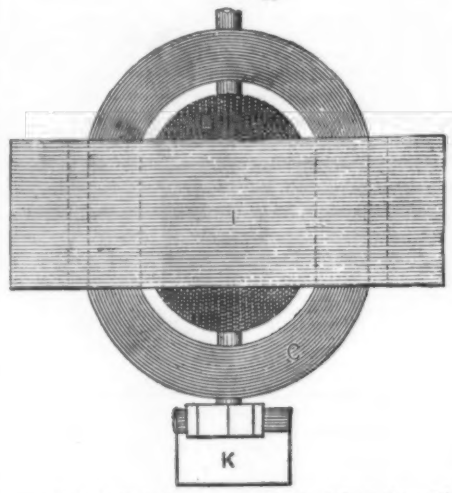


an idea of the construction of the motor referred to. C C' are the field coils or inducing coils, which alone are put into the actuating alternating circuit. I I is a mass of laminated iron, in the interior of which the armature revolves with its three coils, B, B², B³, wound on a core of sheet iron disks. The commutator short-circuits the armature coils in succession in the proper positions to utilize the repulsive effect set up by the currents which are induced in them by the alternations in the field coils. The motor has no dead point, and will start from a state of rest and give out considerable power, but with what efficiency is not yet known.

A curious property of the machine is that at a certain speed, depending on the rapidity of the alternations in the coil, C, a continuous current passes from one commutator brush to the other, and it thus performs the function of converting some electric energy from an alternating to a continuous form.

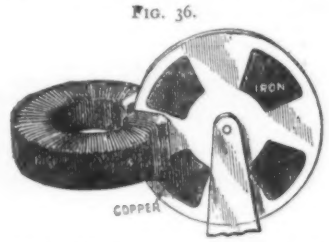
A small motor of a curious type has been made, utilizing the principle of "shading" the pole by closed circuits. A laminated ring (Fig. 36) is wound over with wire, but has a slot cut through it, driving the ring, and causing it to present two pole faces opposite to each other on the cut part. Each pole is arranged by a set of closed copper bands to be "shaded." A

Fig. 35.



copper disk, free to turn on the shaft, is introduced by one edge into the air gap in the magnet, and turns rapidly when the magnet is excited. A silver coin held just at the edge of the air gap, in such an alternating magnet with shaded poles, is drawn into the interpolar space and propelled with some force through the same; but a lead disk or coin of base metal is not acted

Fig. 36.



upon nearly by the same force, owing to its inferior conductivity.

I have left myself but little time to speak of numerous applications of these principles in alternating current meters. The well known meter of Mr. Schallenberger was described to you here quite recently by Professor Forbes. There is, however, a new form of meter, designed by Messrs. Wright and Ferranti, which exhibits in a most beautiful manner a practical application of some of these principles which have briefly occupied our attention. In Fig. 37, we have a diagram of this meter. It consists in its latest form of a pair of vertical electro-magnets—magnets having divided iron cores. To the poles of these magnets are attached curved horns of divided iron, which lie in a horizontal plane.

These curved horns are magnetically throttled at intervals along their length with copper bands. The curved horns embrace a circular space, in which can revolve a light copper or iron shallow cylinder of thin metal.

This cylindrical band forms the periphery of a light wheel capable of rotation on a vertical axis. Geared to this axis is a counting mechanism. The axis also carries a vane, having mica blades. The electro-magnetic principle may be briefly described thus:

The throttling of the curved iron horns causes the rapidly reversed magnetism to take the form of a lateral diffusion of lines of force from the sides of the horns. In effect a series of oppositely named magnetic poles travels along the horn from the base, where it is in contact with the top of the electro-magnet, to the tip. These poles are represented by a series of bunches of lines of force setting out laterally from the sides of the horn, and traveling up it. The lateral passage of these lines of force through the metal band which forms the rim of the movable wheel generates in it eddy currents. These are continually repelled by the

Figs. 37 and 38.

moving field producing them, and hence a motion of rotation is given to the wheel by the alternating magnetism of the magnetic poles. The speed of rotation, being retarded suitably by the vanes, can be made to be proportional to the current strength of the current exciting the magnets, and hence the total turns of the wheel in a given time to the total electric quantity flowing through the meter. A beautiful adaptation has here been made of the principles we have been briefly studying, and much more might be said in explanation, or rather in elucidation, of the action of this meter, did opportunity permit.

It would take me beyond the limits of the time during which I am permitted to trespass upon your attention, if I were to attempt to exhaust the list of electo-motor applications that have been made of these electro-magnetic repulsions. That is a subject important enough to deserve a separate treatment. In Berlin not long ago I saw a most ingenious form of self-starting alternating current motor, the invention of Herr Von Dolivo Dobrowolsky, in which the rotating portion was merely a solid iron cylinder, constituting a commutatorless armature, revolving in an alternating field, and which acted in a perfectly marvelous manner. The region of practical invention here opened is a very wide one, and I have therefore ventured to direct your thoughts to it to-night, confident that its character in this respect deserves all the attention it can obtain, and that a firm foundation for such work is laid in these interesting researches of Prof. Elihu Thomson.

THE LINEFF MAGNETIC CONDUCTOR.

The Lineff conductor is the first in which advantage is successfully taken of the force of magnetism in closing the circuit in electric traction. The surface rails are laid in lengths of about 3 feet in a bed of asphalt, and as they are without any groove, and have their upper surface flush with the roadway, they cannot form any obstruction to traffic, either along or across the track. In point of fact, they are hardly to be distinguished from the roadway itself. Each of these rails is bolted by means of brass bolts and distance pieces to a piece of tee iron of equal length, so placed as to have its base on the same level as that of the surface rails, at a distance from it of about ¼ inch. The tee iron, being of lower height than the surface rail, does not appear at all on the roadway, being completely buried in the asphalt surrounding the whole. One end of the tee iron projects beyond the corre-

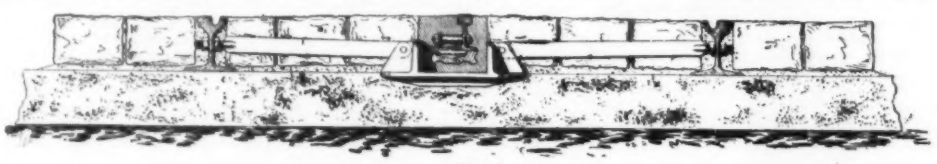


Fig. 1.

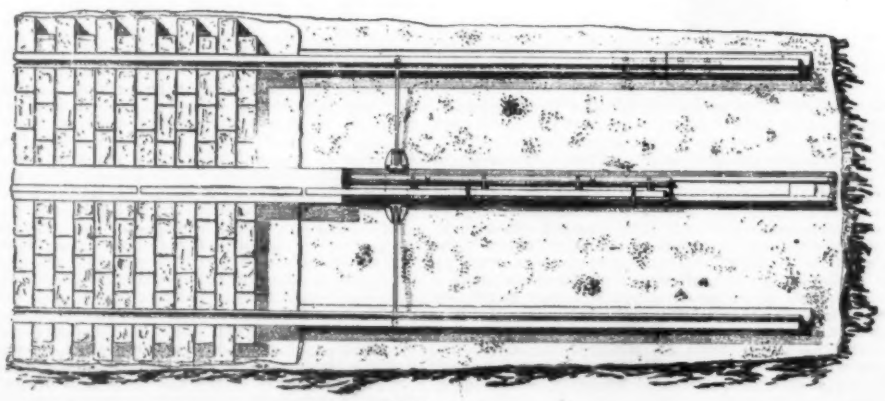


Fig. 2.

THE LINEFF MAGNETIC CONDUCTOR FOR TRAMWAYS.

sponding end of the surface rail, so that the rails, when laid in position, break joint with one another all along the road. The two irons together form a roof to a continuous channel 3¼ inches wide, formed by insulating tiles, on which the irons rest. This channel contains the bare copper main shown in the illustration as a flat strip, and on this rests a flexible hoop iron 3 inches wide, which is free to rise into contact with the lower flanges of the surface and tee rails, from which it is in its normal position distant about $\frac{1}{16}$ inch. Each car carries underneath it an electromagnet, each pole of which contains a solid iron wheel which runs on the surface rail. The distance between the pole pieces is slightly greater than the length of one section of the surface rail, so that the two poles are never on the same section. The magnet is energized by the main current, the wire forming the coils being coupled in shunt with the motor circuit. The magnetic lines emanating from the magnet poles pass into the surface of the rail. The section of this being insufficient to carry the whole of the magnet lines, a large proportion of them leak across to the buried tee rails, and as the connection between each pair of rails (surface and buried) is of a non-magnetic material, the lines jump across the air space between the lower flanges. Opposite poles are consequently induced in each of the surface and tee rails under the immediate influence of the electromagnet, and the leakage "cross" lines, being diverted through the strip of hoop iron lying immediately below the air gap, in their attempt to shorten themselves attract the hoop iron into contact with the bases of the surface and tee rails; both of which, as they are in electrical (though not in magnetic) connection, assist in taking off the current. The system would appear to adapt itself especially to tramways in the crowded thoroughfares of large cities. There are no overhead wires, and there is no slot in the rod. Another advantage of the Lineff magnetic conductor is that it dispenses with the extra load and cost of storage batteries.—*Iron.*

SACCHARINE.

THIS now famous substitute for sugar is only ten years old, having been discovered a decade since by Mr. Fahlberg, a New York chemist. It is extracted by a rather protracted process from the tar formed in the dry distillation of coal. In a pure condition it is a white amorphous powder, the sweetening capacity of which is three hundred times that of the finest refined sugar. When the discovery was first announced, it was naturally received with incredulity by persons who regarded it as one of those fictions in which the United States is so fruitful. When, however, through the publication of the process, it was possible to produce saccharine in any laboratory, the fact of the invention had to be admitted, but it was believed that the product had only value as a pharmaceutical preparation. The fallacy of this belief was speedily demonstrated, for, favored by its comparative cheapness and some other circumstances, it soon acquired an important position in industrial life. It readily found employment in the manufacture of preserves, sweets, chocolate, liqueurs, and even in the production of wine and beer, in the place of sugar, which till then had been exclusively employed. It was only natural that the Fahlberg discovery should stimulate other chemists to fresh experiments in the same field, and among the competing articles arose the so-called methyl saccharine, patented by the proprietors of the well-known tar manufactory at Ludwigshafen-on-Rhine.

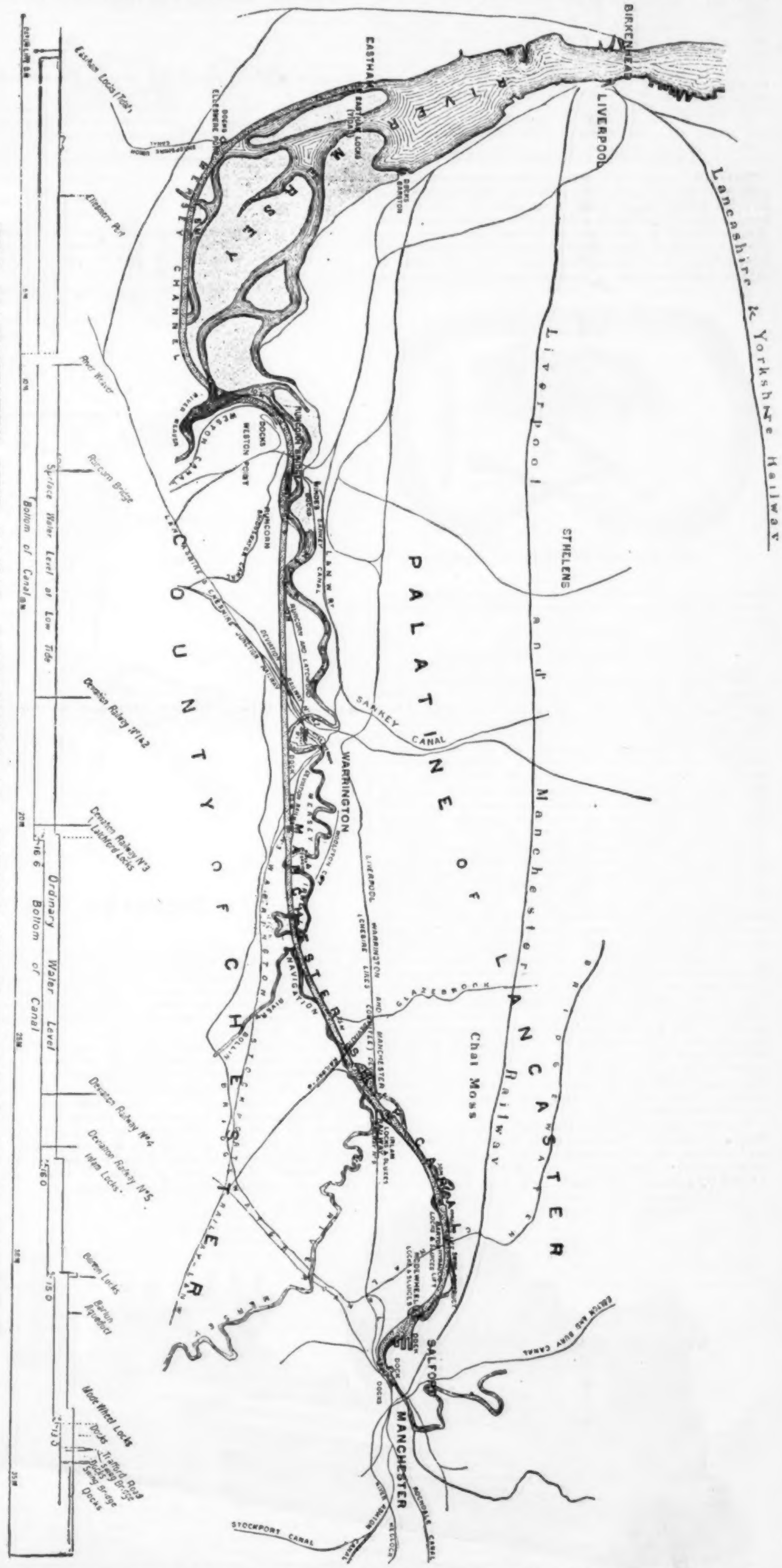
The growing popularity of saccharine was the means of attracting the attention of a number of governments, who were mainly concerned with the question as to the influence the new product would have on the revenue. Several authorities also affirmed that the use of saccharine was not altogether conducive to health. In this relation the results of the experiments of a number of scientists, undertaken at the instance of a Comité consultatif d'hygiéne, of Paris, are of much importance. It was established that saccharine restrained the assimilation by digestive organs of starch and albuminous-containing foods taken at the same time, in consequence of its antiseptic properties, and that it was itself no food stuff, as after being eaten it underwent no alteration and was expelled from the system in its original condition.

In view of these circumstances, the Dutch delegates at the International Congress for the Abolition of Sugar Bounties, held in London in 1888, were induced to recommend the adoption of a common line of action on the part of the governments against saccharine. Nothing has, however, been jointly accomplished, but a number of governments have since adopted measures of more or less severity with the object of restricting the consumption of saccharine in place of sugar. Apart from England, in which country an act has been passed prohibiting the employment of saccharine in the production of excisable articles, beer in particular, the Portuguese government was the first to adopt decisive measures. In a royal decree issued the 9th of August, 1888, the importation into Portugal of saccharine and saccharine-containing products was entirely prohibited, excepting for medical purposes, for which special permission had to be obtained on each occasion. The importation of saccharine into France and Algeria was prohibited by a decree of the president of the republic dated the 1st of December, 1888. In a decree dated the 3d of April, 1889, the Spanish government not only prohibited the importation of saccharine into Spain, but also made its employment in food stuffs as a substitute for sugar a penal offense. In Belgium, the law of the 21st of May, 1889, imposed an entrance duty of 140 frcs. per kilo. on saccharine and on all articles containing down to ½ per cent. saccharine. In Holland, saccharine has for long had to pay an ad valorem duty of 5 per cent. as a drug, but it is probable that the long-entertained intention to impose a duty of 60 florins per kilo. will be carried into effect. By a decree dated the 26th of July, 1888, the Italian government placed an entrance duty on saccharine of 10 lire per kilo., but it soon became apparent that so light a duty was neither in the interest of the state or of the sugar refiners. A bill has, in consequence, lately been introduced into the Italian Chamber prohibiting the importation of saccharine and saccharine-containing products, special provisions being made for saccharine for medical purposes. In Russia, the customs authorities decided in February last year that saccharine should be classified under chemical and pharmaceutical products not otherwise specified, the duty on which was 2 rubles 40 copecks per *pud*. As the duty on sugar is 3 rubles 50 copecks, that on saccharine is ridiculously low. It is now proposed in Russia to prohibit its importation altogether.—*Kuhlow.*

THE MANCHESTER SHIP CANAL.

DURING the past month the directors have decided to use their best endeavors to open the portion from Eastham to the Weaver as soon as possible, and for this purpose both men and material are being concentrated on the length in question. It is hoped that by Christmas the waterway will be ready for the passage of the Weaver traffic. Under ordinary circumstances we should not hope for the fulfillment of this anticipation, since, although an immense amount of work has been done, a great deal yet remains to be dealt with.

We publish a general map of the district traversed by the ship canal from Eastham, where it debouches into the Mersey, about six miles above Liverpool, showing the lines of the various railway companies and the smaller waterways in the immediate neighborhood of the ship canal; also a longitudinal section showing the position of the locks between Manchester and Eastham, and the alterations of the level at each.



THE MANCHESTER SHIP CANAL—LONGITUDINAL SECTION FROM EASTHAM TO MANCHESTER.

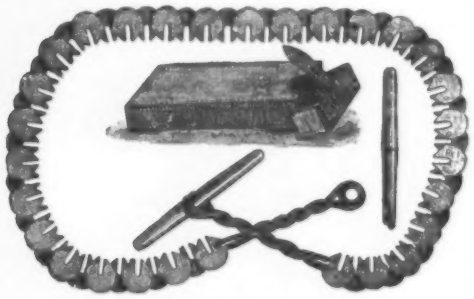
The total length from the Manchester docks to Eastham is thirty-five and a half miles, divided by locks into five reaches or ponds, and the difference in level of the surface at the docks and of the lower pond will be 60 ft. 6 in. The upper locks are being built at Mode Wheel, and these maintain the necessary level of

water at the Salford and Manchester docks, which consequently require no dock gates, and allow freedom of movement for vessels and their attendant barges.

At Mode Wheel there are two locks, 600 feet by 65 feet, and 350 feet by 45 feet, and locks of similar dimensions are in course of construction at Barton, Irlam, and Latchford, the four sets of locks being situated at thirty-three and a half, thirty and a half, twenty-eight, and twenty and a half miles from Eastham respectively. The falls provided for, commencing at the upper end, are: At Mode Wheel, 13 ft.; Barton, 15 ft.; Irlam, 16 ft.; Latchford, 16 ft. 6 in.; total, 60 ft. 6 in. To deal with the flood waters coming down the river valleys, sluices are provided at each set of locks; at Mode Wheel four, at Barton four, at Irlam five, and at Latchford three sluices, all of 30 ft. span. The minimum depth of the canal is fixed at 26 ft., with a bottom width of 120 ft. to this depth.—*The Engineer.*

STANLEY'S PORTABLE SAW.

THE saw is made of hardened steel plates riveted together in double series; the rivets are sufficiently loose to form joints; each plate is shaped on one side to form a pair of saw teeth cutting in opposite directions. A cross handle at each end of the saw fits into a ring for use; these handles are withdrawn from their rings for packing; for inaccessible trees, etc., ropes may be attached to the rings in place of the cross handles. It



STANLEY'S PORTABLE SAW.

can be used by one man; weighs complete only 2¼ lb., including case, which measures over all 1¾ in. by 4 in. by 8 in.

HEAVY CRANKSHAFT LATHE.

WE illustrate a 48 inch heavy crankshaft lathe, constructed by Messrs. George Richards & Co., limited, Broadheath, Manchester. The bed is 35 ft. long, 3 ft. 6 in. wide, and 2 ft. deep, and weighs about 15½ tons. The fast headstock is capable of twenty-four different speeds, while two sets of pulleys on the countershaft enable these speeds to be doubled. This headstock is shown in Figs. 1, 2, 3, 4, and 5, of which Fig. 4 is a horizontal section through the main spindle, and Fig. 5 is a vertical section through the cone pulley shaft. There are four steps on the cone pulley. This pulley is loose on its spindle, but can be connected in the usual way to the wheel, 19, fast on the shaft. Fixed to the other end of the cone pulley are two pinions, 20 and 21, which gear, one at a time, with the wheels, 22, 23, on the back shaft, D. These wheels can be slid along the shaft to bring either into gear. The backshaft itself is moved to and from the cone pulley shaft, C, by eccentrics in the usual way. The pinion, 23, on the backshaft gears into the wheel, 19, on the cone pulley shaft. The faceplate can be driven in two different ways. For slow speeds a pinion at the end of the cone pulley shaft gears into teeth around the faceplate (Fig. 3). This pinion, which is 8 in. in diameter, can be moved in and out of gear by a handwheel. For fast speeds the main spindle, A, is driven direct by the wheel, 18, which can be clamped to a plate fast on the spindle. When the back gear drives on to the spindle the wheel, 19, becomes an intermediate wheel. The spindle is of steel, with bearings 10 in. in diameter and 12 in long. There are five thrust collars on the rear bearing, while the forward bearing is plain.

The carriages, of which there are two, are shown in Figs. 6, 7, and 8. They are each moved by two racks and pinions, one set at each side of the bed to prevent cross strains. The pinions at the two sides are connected by gear and the shaft, A U, Fig. 7. This shaft is driven at the right hand end by the feed gears in the front apron, while in the left hand it drives through a train to the pinion, 81 (Fig. 8). In this train is the equalizing wheel, 79, which is so arranged by means of set screws and lugs that equal strain can be put on each rack. This shaft also drives through the wheels, 82 to 86, the two cross screws, A S, A T. Wheel 83 is carried on swing plate, and change wheels can be introduced to vary the speeds of the cross screws, and to give the rest such a motion as to produce any desired taper in the work.

For ordinary surfacing work these screws are driven from the front or main feed train. Upon the feed rod, B, is a sleeve, 61, carrying a bevel pinion at each end. By means of the handwheel and screw, W, either of the pinions can be put in gear with the wheel, 62, a pointer (Fig. 9) showing when the engagement is complete. The motion is transmitted through the wheels, 63, 64, 65, 66, 67, to the central wheel, 68. Two pinions on swinging brackets (Fig. 11) enable this wheel to be put in gear with the pinions on the ends of the cross screws as desired, two small eccentrics with crank handles (Fig 12) enabling each pinion to be instantly withdrawn when required. From the wheel, 68, motion is transmitted to the rack pinion through the wheels, 70 and 71. The band gear acts through the wheels, 73, 74. The saddles are 6 ft. in length. The footstock spindle is of steel, 6 in. in diameter, and the total weight of the lathe is about 26 tons. All the wheels are machine cut.—*Engineering.*

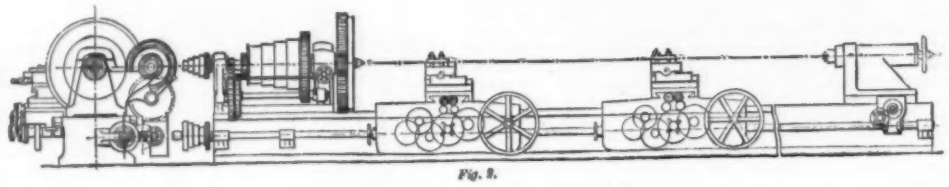


FIG. 2.

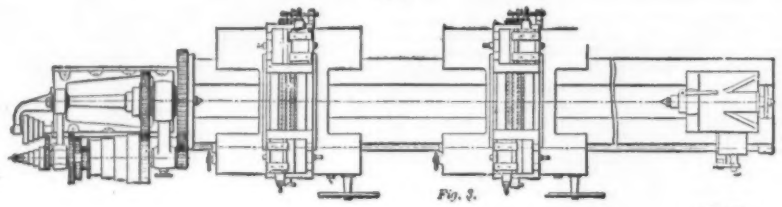


FIG. 3.

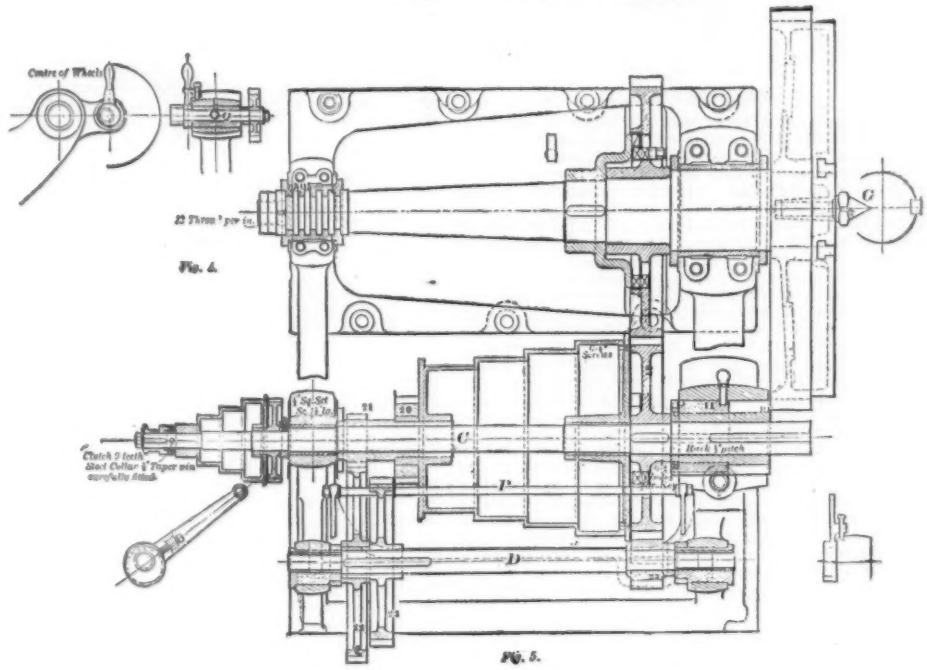


FIG. 4.

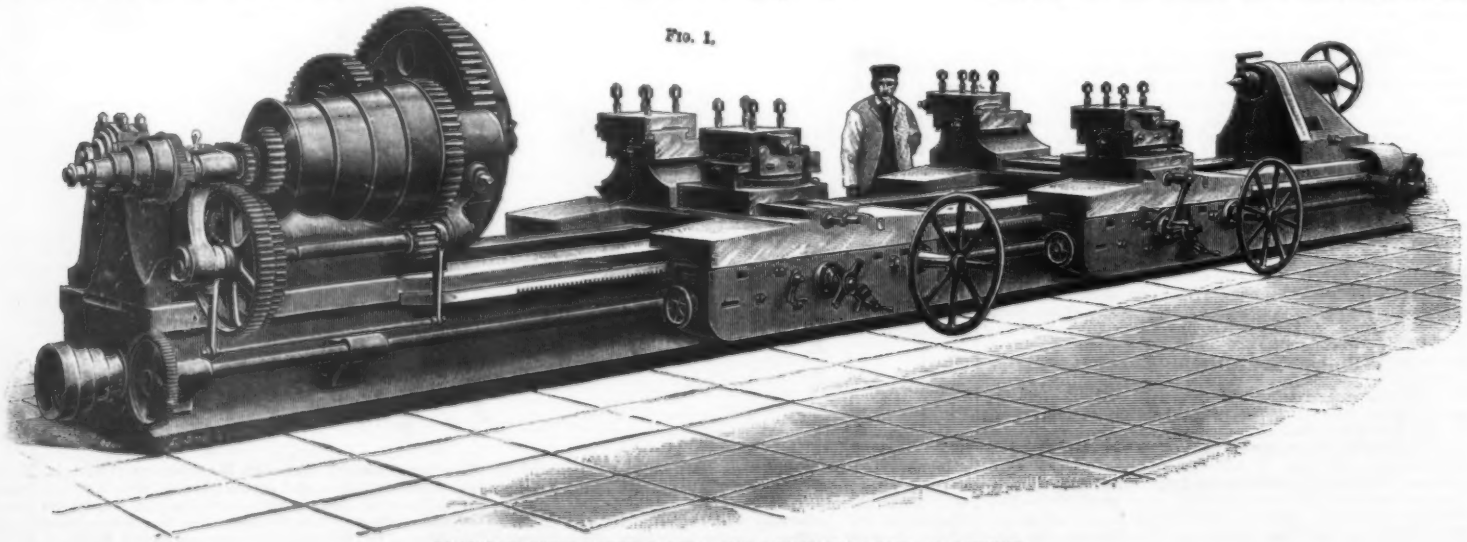
FIG. 5.

IMPROVED HEAVY CRANKSHAFT LATHE.

MACIVOR'S IMPROVED WHITE LEAD PROCESS.

ONE of the most important industries of the United Kingdom is the manufacture of white lead, or, to employ its chemical term, basic carbonate of lead, which is an essential compound in pigments. It has hitherto for the most part been produced by the Dutch or stack process, which is an expensive, tedious, and dangerous operation. It is expensive because the dearest desilverized lead must be used, and because of the labor involved; tedious because three or four months are required to convert the lead into carbonate; and dangerous to life because the atmosphere of the rooms in which the material must be handled is charged with poisonous dust. Our columns testify to the fact that many attempts have been made to manufacture white lead in a cheaper, quicker, and less dangerous way, but most of them appear to have proved to be abortive, or else the material produced has been crystalline in structure, and consequently has not had the covering power of the Dutch white lead. Recently, however, a process has been discovered by Professor MacIvor, F.I.C., which appears to overcome all the objections to the ordinary stack process, and promises to render the manufacture of white lead economical, quick, and safe. Some little time since Professor MacIvor made the discovery that litharge, or oxide of lead, is soluble in a certain alkaline solution, which hydrates the lead, and that when in this condition the hydrate

FIG. 1.



IMPROVED HEAVY CRANKSHAFT LATHE.

combines with carbonic acid gas and forms white lead or a true basic carbonate of lead, liberating the alkaline solution, which is recovered to attack fresh charges of litharge. Since this discovery was made a further step has been taken in the way of economy in producing the lead. Carbonate ore, which is found in great abundance and may be bought at a very low price, is roasted at a moderate heat. It then yields carbonic acid, the residue being oxide of lead (litharge or massicot) and gangue, or impurities. These are removed by washing, and the litharge is afterward treated with the alkaline solution. There is thus a cycle of operations tending to the production of pure carbonate in the most economical way.

The manufacture of white lead on this principle has been carried on for the past nine months at the experimental works, 47 Clapham Road, London, where we recently inspected the process, which is a very simple one. The litharge is first prepared from lead ore, and is thoroughly purified by washing. A charge of the pure litharge is then put into a closed vat, in which are revolving stirrers, and a solution of acetate of ammonia is added to it, and the stirrers are started. This mixture is agitated for six hours, at the end of which time the lead will have been wholly absorbed into the ammonia solution. It is then allowed to settle, and the supernatant liquor containing the lead is pumped over into a second vat, similarly constructed to the first one. In the second vat the solution is submitted to the action of carbonic acid gas, when the pure white lead is precipitated from the acetate of ammonia, which is thus recovered, and is ready for use again. It is stated that the solution has been recovered and used over again fourteen times. If the litharge is exceptionally pure, one vat only is employed, the carbonic acid gas being introduced into the first one. The result is as in the other case, the production of pure white lead and the recovery of the acetate of ammonia. Whichever way the lead is produced, whether by the aid of two vats or only one, the mother liquor is next run off, and the white lead is passed through filter presses, to deprive it entirely of mother liquor. The pressed lead then goes to the washing apparatus, where it is agitated for a time in a bath of cold water, and is then allowed to settle, when the water is drawn off. Fresh water is then added, and the lead undergoes another washing. This process is repeated eight times, when the white lead is found to be sufficiently washed. It is then again passed through filter-presses, and is finally submitted to hydraulic pressure, in order to extract all the moisture capable of removal by mechanical means. From the hydraulic presses the white lead is taken to the drying room, where it is dried at a temperature of from 160° to 180° F., when it is ready for use. We thus have a high class white lead, which equals, and in some respects excels, that produced by the Dutch process, inasmuch as in the latter traces of crystals are discernible, while in the former they are not detectable.

It is claimed that by this method white lead can be prepared for the market at a cost below that of the pure lead required to make stack lead, and that it can be made in six hours, as against four months by the older system. Professor Crookes, F.R.S., Dr. Dupre, F.R.S., Professor Dittmar, F.R.S., and Professor Watson Smith, F.I.C., and other eminent chemists have reported very favorably upon the economy of the manufacture and the excellence of the product. A further point is that all the operations are carried out in the wet way, so that there is consequently no dust, and danger to health is entirely avoided. This, in itself, is an important consideration, because the coroners' records at Newcastle and elsewhere tell a sad tale of the sacrifice of life in connection with the manufacture of white lead. As regards the commercial side of the question, it is stated that from the moment the ore enters the furnace to be roasted, until it reaches the washing vat in the shape of white lead, a period of only from eight to twelve hours elapses, while with the Dutch process a period of from three to four months is necessary. Although there is such rapidity in the conversion of the ore into the finished product, not a crystal is to be found in it. In this respect, therefore, the white lead is superior to that made by the Dutch process. On the score of economy of production, all that need be said is that, as stated, this amorphous carbonate of lead is produced by the MacIvor process at about £2 per ton under the price of the lead metal with which the Dutch process starts. This being so, the process promises to be as great a commercial as it is a scientific success.—*Iron.*

SILK CULTURE IN FRANCE.

WITH reference to the recent demand of certain delegates representing the agricultural, and especially the silk-growing, industry of southern France for a protective duty upon imported cocoons and raw silks, with certain restrictions upon silk manufacturers in respect to "loading" their goods in the process of dyeing, the United States consul at Marseilles gives a sketch of the history and present condition of this branch of French industry. The cultivation of the mulberry tree for the rearing of silkworms began in the south of France early in the seventeenth century, but it was not until 150 years later that the industry became important or largely profitable. By the year 1780 the annual product of cocoons had risen to 6,600,000 kilogrammes, which were then worth about 2s. a kilogramme.

This was a lucrative result in those frugal times, and the business continued to flourish until 1853, when the crop reached 26,000,000 kilogrammes at about 8s 9d the kilogramme, thus adding a sum of about £4,700,000 to the wealth of the rural classes. The country was admirably adapted to the growth of the mulberry leaf, the warm dry climate of Provence and Comtat Venaissin was favorable for the worm; the labor of raising the cocoons and reeling them could be performed by women, aided to some extent by children and aged people, thus entailing scarcely any increase in the expenses of the farm, and the permanent prosperity of the industry seemed for a time assured. Then a series of disasters began. The peasants, in their eagerness to raise every possible silkworm, had for years overstocked their premises, and in the crowded, ill ventilated, and often dirty and neglected *magnaneries* the worms degenerated from year to year until they became a prey to several new and destructive diseases.

The most serious of these were the *muscadine*, which was thought to have been imported with silkworm eggs from Turkey, and the *pebrine*, a malignant cryptogamous infection, generated by the conditions above cited, and which is commonly cited in France as *la maladie*. The *muscadine* caused a loss of £800,000 in a single season. In thousands of cases every silkworm in a farmhouse or breeding establishment perished, and this disease was succeeded by the *pebrine*, which swept the silk-growing district irresistibly, until a discovery was made which provided a practical escape from its ravages. The discovery was a new and certain method of detecting the disease in the chrysalis, or moth, which lays the eggs that serve as the seed for next year's growth of silkworms. By the time, however (1880–81), that this remedy was generally known and practiced, the situation had become in other respects almost hopeless. After the war of 1871 wages and the cost of living had greatly increased. Selling prices for farm produce of all kinds, which had formerly been ample, were no longer sufficient in many cases to pay the cost of production. The price of cocoons, which at one time had been as high as eight francs a kilogramme, fell to six and then to four francs, and even less. Discouraged by disease and low prices, thousands of farmers rooted up their mulberry trees for firewood and devoted the ground to vines and other forms of culture. The skilled women, who had formerly gathered the leaves for the silkworms and reeled the cocoons, had gone to other employments at higher wages than the languishing silk industry could afford to pay. By this time French manufacturers no longer depended upon home-grown silk.

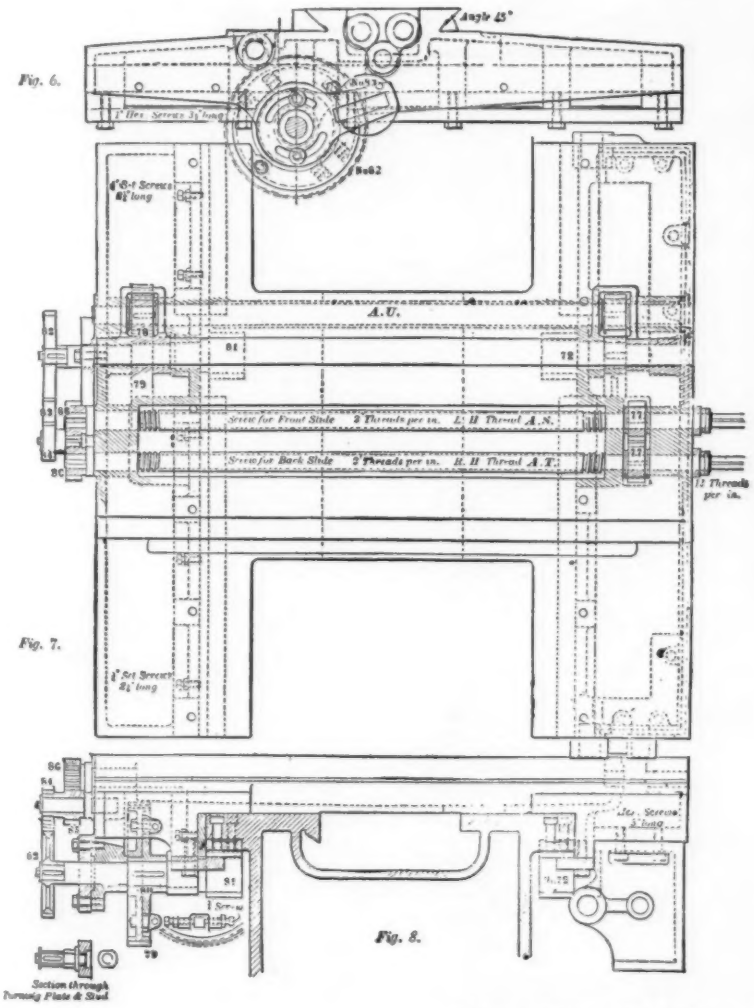

Angle 45°
A.U.
Screw for Front Slide 2 Threads per in. L. H. Thread A.N.
Screw for Back Slide 2 Threads per in. R. H. Thread A.T.
12 Threads per in.
Section through Turnsby Plate & Stud

Fig. 6.

Fig. 7.

Fig. 8.

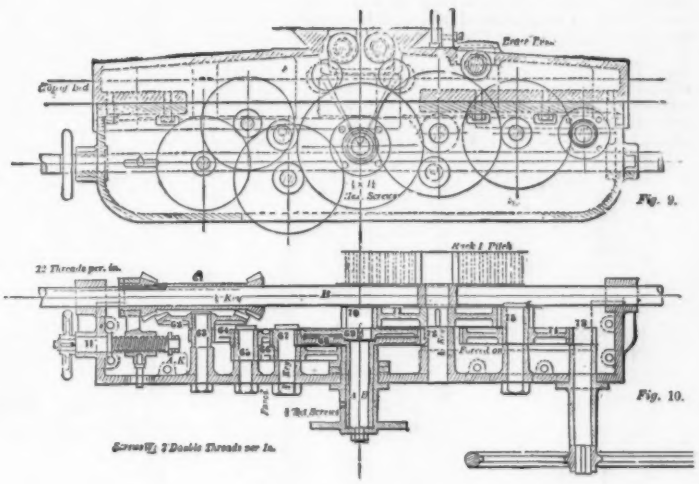


Fig. 9.

Fig. 10.

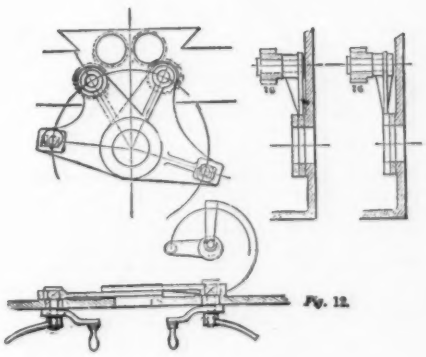


Fig. 11.

Fig. 12.

IMPROVED HEAVY CRANKSHAFT LATHE.

During recent years important discoveries in the chemistry of silk manufacture had enabled the spinners, by skillful dyeing and "loading" their goods with gums and mordants, to use inferior grades of Japanese, Chinese, and Italian fiber, in place of the superior organzines which had given the fabrics of Lyons and the ribbons of St. Etienne their luster and renown.

It is urged that the manufactures were protected by high import duties, but the raw material which fed their looms was, and still remains, duty free. It is said that the weighing and loading of French silks has been carried to an extent which has injured their reputation, and not only disgusted French consumers of such goods, but has raised the question whether the use of so much low grade Asiatic fiber has been, after all, a blessing to the manufacturers of France. There is now a new and steady demand for better material, and the question has now arisen—why not protect the native silk growers and raise it at home? It is argued that it is solely due to the competition of foreign cocoons, and the increasing use of low qualities of silk, loaded with fraudulent dyes, that French silk culture has languished since Pasteur's discovery conquered the malady which had threatened its existence. The peasants of France, who hatched more than a million ounces of silkworm eggs in 1872, used less than a quarter of that quantity in 1886. In conclusion Consul Mason says: "The government, which had increased the duties on wheat and cattle, left the agriculturists without protection, and seeing no hope of relief, many have given up the struggle, and either emigrated to South America or flocked to the already overcrowded

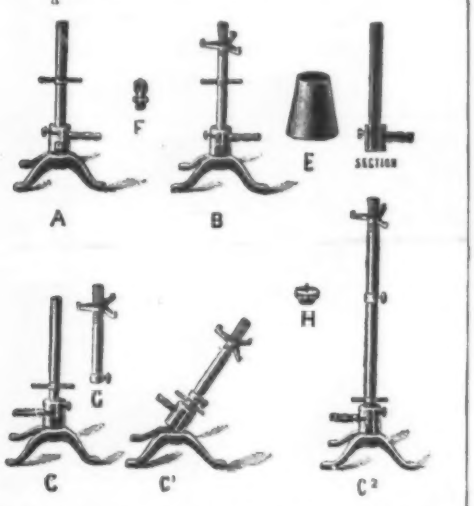
cities and towns. There are, in this consular district, six rural departments in which the population is steadily decreasing, and this decadence of agricultural prosperity involves a serious menace to France."

NEW AND IMPROVED FORM OF BUNSEN'S BURNER.

MR. J. R. GRIFFIN, before the Society of Chemical Industry, exhibited some new forms of Bunsen's lamp. The first, A, was the invention of G. Reimann, of Berlin, Eng. pat. 20,744, of December 24, 1889. The others were modified forms of Reimann's lamp made by Mr. Griffin's firm (J. R. Griffin & Sons), at the suggestion of Mr. Watson Smith, and with the consent of Herr Reimann.

Briefly it may be stated that in this new lamp the novelty is the simultaneous and corresponding regulation of the admission of gas and air to Bunsen burners. To this end the short vertical tube or jet used in ordinary Bunsen burners for the admission of gas into the outer tube (the lamp) is dispensed with, and the burner —or outer—tube is made to act as a regulating cock both for gas and air.

In order thus to serve as a regulating cock, the extremity of the burner tube tapers to a conical shape, and is ground so as to fit the tube forming the base of the lamp and containing the air holes, so as to form in it a kind of plug cock, as a stopper does in the neck of a bottle. The gas enters the piece of metal tube, fixed at right angles to the burner tube, but at its extremity directly enters the burner by a horizontally disposed orifice, which, on turning the burner tube, is gradually closed. This arrangement obviates the objectionable "firing back" of the flame when the supply of gas is reduced. Mr. Watson Smith's additions consist (1) in a telescope tube, G, fixed around the burner tube of the ordinary lamp, C, the effect being to make possible the raising or lowering of the position of the lamp flame at will (*vide* C^1); (2) in a hinge arrangement at the base, such that the lamp tube may be inclined at any angle (as at C^1), or placed in a horizontal position if desired; (3) in a cylindrical brass perforated shield placed around the base containing the air holes, so that by revolving this around the base the air holes are either gradually and at last entirely closed, or gradually and at last entirely opened, as the case may



be, and with ease; and (4) in the addition of a gallery with chimney, E, for protecting the flame. No. 2 addition is most especially useful in the process of soldering, or in the burning of filters over glazed paper in gravimetric analysis, etc. The telescopic arrangement (No. 1) is found very useful in fractional or ordinary distillations.

THE ART OF WORKING IN LEATHER.

THAT our schools have developed a higher tandard of taste is plainly indicated by a constantly growing demand for articles that are made by hand, as being more artistic and interesting than those that are machine made. A class of educated purchasers is rapidly springing up, who prefer hand work that has a character of its own, to the machine product, which, however perfectly finished, is always monotonous and wearisome.

One of the easiest arts for making pretty and useful objects for home use or decoration, or for sale, is that of working in leather. It ranks as high as any decorative art, and those who practice it should bear in mind that it is not an imitative art. They must treat leather as a really plastic material, and seek to obtain such skill in handling it as to be able to mould and model it like wax, and with a little practice this is easily accomplished. All the materials used are cheap and easily procured, while the tools are simple. You will need a penknife, scissors, pencil and compasses, a rag full of sand tied up tightly, two pattern makers, one with a smooth wheel and one with a sharp pointed wheel. The other tools you can whittle out of any wood. No. 1 is for scraping, marking, working the leather into corners and drawing lines; the others are wooden chisels, bodkins and gouges easily made. No. 10 is for marking or stamping the background of your work. It is also made of wood.

Take a common dinner plate for a mould. Cut out about twenty round pieces of newspaper, each a little larger than the plate. Lay one on, paste over it, and lay on another piece, pressing down with fingers and sandbags. When of sufficient thickness, trim the edges, and remove when dry. To ornament the surface, cut out of cardboard some leaves or Gothic letters, making them as thick as you like by adding layers, and paste or glue them on the core. Or else paste twenty thicknesses of paper together, draw a pattern and cut it out. Figures of animals, flowers, heraldic designs, make very pretty ornaments. Now take a piece of skiver leather, one or two inches larger in diameter than the plate, steep it in hot or cold water until of sufficient pliability, and lay it on your core. Begin at the center and press it on to the core with fingers and a wet sponge. Work the leather into the designs with the wooden bodkins, pressing it carefully into every corner. After a few trials you will become expert at the work, though clumsy at first. When the pattern is nice and clear, take your cross hatch, stamp and indent the background, finishing the corners with wooden bodkins. Glue skiver over the back of your plate, pulling the front edges over and gluing them down. If carefully done, you will have a very creditable piece of work. Make several card receivers and practice ornamenting the leather with stains, gilt or paint. A good black stain is made of printer's ink. Many of the cheap common dyes make good stains. Cut out leaves or other designs from colored leather and glue on the skiver cover, using your wheels to press down the edges. Collect and draw as many leaves and flowers as possible and study designs to ornament your work.

The most artistic way to work leather is to indent basil sheets with strong bone bodkins. Of this order is the old *cuir bouilli* work of the Orient, and which fetches quite a high price. It is easy to make and has a charming appearance. Macerate the basil in hot or cold water, to which is added a teaspoonful of alum or salt to the pint, until the leather is soft and workable The following is a copy of a Florentine calunac or pen and ink case of the 14th century. Mark your pattern, wheeling out the lines, and then press down the background with the bodkin. The repousse may be raised half an inch by working on the other side as well. Coat the back with shellac, filling out the hollows with sawdust and glue, cement or plaster of Paris mixed

THE ART OF WORKING IN LEATHER.

with alum and mucilage, and stain according to your taste. Very pretty work is made by contrasting light and dark brown or black and brown. When you have succeeded in making several of these little ink cases with different ornamentation, try your skill on a music roll, book cover, chair back, or a panel for a door, or a mat to protect the wall in front of a washing stand. Waterproof the leather with bichromate of potash and glue. A thin coat of varnish will sometimes improve your work. For a music roll prepare a core of papier-mache, well hardened and rolled; roll it round a rolling pin and stitch or glue the edges together. Glue your ornament sheet of leather on this, and you will have a good music roll. Of course you can paste ornaments on the core and cover with a sheet of skiver. A is made on a smaller cylinder, while B and C are made on one of the diameter of A.

Very pretty bonbonnieres are easily made of leather, and find a ready sale. Make them in shapes of fruits, birds, animals or books. Cigar caskets are very effective and artistic. In fact leather can be made to serve innumerable practical and ornamental purposes at a very slight expense, and for a high profit.

Of course you can have all these tools in bone or ivory, and the cross hatch stamp may be of metal, but it is not necessary. You can procure waste leather scraps of any bookbinder, and you can buy whole skins called skivers for a dollar or so apiece—this is the thin, supple leather; the basil is of better quality and thicker, and will cost a little more. Secure as many old newspapers as you can, and keep plenty of flour paste handy. You will need some shellac, such as painters use to cover knots in wood; applied to the back of leather, it makes it as hard as wood; a little alum powder; and, for waterproofing leather, bichromate of potash mixed with a little glue. This last is a poison, and care must be taken not to inhale the fumes. Gather a good deal of saddlers' and shoemakers' waste stuff, fine sawdust and soft rags. If you can carve wood just a little, it would be all the better, and a few days spent in practicing would repay any leather worker. By cutting leaves into the wood you have a mould into which you can press your softened leather; for with sewed leather work, by which thin sheets of leather are treated as cloth, or sheet leather work, by which imitation flowers, etc., are made, this article has nothing to do.

The outside surface of the simplest leather work is always made of sheets of skins, the interior or core is made of leather pulp, papier-mache or anything that can be moulded and hardened, but the beginner will find the papier-mache the easiest material to manage. The ornaments on the surface are made by working with punches and wheels, or by stamping and printing with dies or moulds. Make first a card receiver.

THE NATURAL HISTORY OF CHAMPAGNE.

MR. HENRY VIZETELLY has just issued (Vizetelly & Co.) a new and greatly enlarged edition of his book "Facts about Champagne," which seems to tell everything that is worth knowing about the history and mystery of what Thackeray called "the wine of the world."

It is difficult to imagine the world without champagne; yet its origin dates back barely two centuries. It was discovered by one Dom Perignon, the cellarer of the abbey of Hautvillers, who discovered also how to make it effervesce; It was at the close of the seventeenth century that this discovery was made—when the glory of the Roi Soleil was on the wane, and with it the splendor of the Court of Versailles. Louis XIV., for whose especial benefit liqueurs had been invented, recovered a gleam of his youthful energy as he sipped the creamy foaming vintage that enlivened his dreary *tete-a-tetes* with the widow of Scarron. I found its chief patrons, however, among the bands of gay young roysterers, the future *roues* of the Regency, whom the Duc d'Orleans and the Duc de Vendome had gathered round them at the Palais Royal and at Anet. It was at one of the famous *soupers* at Anet that the Marquis de Sillery—who had turned his sword into a pruning knife and applied himself to the cultivation of his paternal vineyards on the principles inculcated by the cellarer of St. Peter's—first introduced the sparkling wine bearing his name. The flower-wreathed bottles which, at a given signal, a dozen of blooming young damsels scantily draped in the guise of bacchanals placed upon the table, were hailed with rapture, and thenceforth sparkling wine was an indispensable adjunct to all the *petits soupers* of the period.

It is asserted by the vintagers that the grapes gathered at sunrise always produce the lightest and most limpid wine. Moreover, by plucking the grapes when the early morning sun is upon them, they are believed to yield a fourth more juice.

Later on in the day, too, spite of all precautions, it is impossible to prevent some of the detached grapes from partially fermenting, which frequently suffices to give a slight excess of color to the must—a thing especially to be avoided in a high class champagne. When the grapes have to be transported in open baskets for some distance to the press house, jolting along the road either in carts or on the backs of mules, and exposed to the

torrid rays of a bright autumnal sun, the juice expressed from the fruit, however dexterously the latter may be squeezed, is occasionally of a positive purple tinge, and consequently useless for conversion into champagne.

The special characteristic of champagne is that its manufacture only just commences where that of other wines ordinarily ends. The must flows direct from the press into capacious reservoirs, whence it is drawn off into large vats, and after being allowed to clear, is transferred to casks holding some forty-four gallons each, in which a sulphur match has been previously burned. These casks are not filled up to the bunghole, which is generally covered with a vine leaf kept in its place by a piece of tile. The bulk of the newly made wine is left to repose at the *vendangeurs* until the commencement of the following year. The first fermentation, entailing a loss of about 7½ per cent., lasts from a fortnight to a month, according to whether the wine be *mou*—that is, rich in sugar—or the reverse. In the former case fermentation naturally lasts much longer than when the wine is *vert* or green. This active fermentation is converted into latent fermentation by transferring the wine to a cooler cellar, as it is essential it should retain a certain portion of its natural saccharine to insure its future effervescence. The casks have previously been completely filled, and their bungholes tightly stopped—a necessary precaution to guard the wine from absorbing oxygen, the effect of which would be to turn it yellow and cause it to lose some of its lightness and perfume. After being racked and fined, the produce of the different vineyards is ready for mixing together in accordance with the traditional theories of the various manufacturers; and should the vintage have been an indifferent one, a certain portion of old reserved wine of a good year enters into the blend.

When champagne is first bottled, the bottles are much given to breaking. It is impossible to check a certain amount of breakage, especially when a hot season has caused the grapes, and consequently the raw wine, to be sweeter than usual. Moreover, when one *casse* or breakage sets in on a large scale, the temperature of the cellar is raised by the volume of carbonic acid gas let loose, which is not without its effect on the remaining bottles. The only remedy is the instant removal of the wine to a lower temperature whenever this is practicable. A manufacturer of the prescientific days of the last century relates how one year, when the wine was rich and strong, he only preserved 120 out of 6,600 bottles; and it is not so long since 120,000 out of 200,000 were destroyed in the cellars of a well-known champagne firm. Over-knowing purchasers still affect to select a wine which has exploded in the largest proportion in the cellars as being well up to the mark as regards its effervescence, and profess to make inquiries as to its performances in this direction.

The corks, which are mainly obtained from Catalonia and Andalusia, cost more than twopence each, and are delivered in huge sacks resembling hop pockets. Previous to being used they are either boiled in wine or soaked in a solution of tartar, or else they have been steamed by the cork merchants, both to prevent them imparting a bad flavor to the wine and to hinder any leakage. They are commonly handed warm to the corker, who dips them. Some firms, however, prepare their cork, by subjecting them to cold water *douches* twice a day during five or six days beforehand. The *ficeleur* receives the bottle from the corker, and with a twist of the fingers secures the cork with string, at the same time rounding its hitherto flat top, at a rate which allows from 1,000 to 1,200 bottles to pass through his hands in course of the day. The *metteur de fil* next affixes the wire with like celerity; and then the final operation is performed by a workman seizing a couple of bottles by the neck and whirling them around his head, as though engaged in the Indian club exercise, in order to secure a perfect amalgamation of the wine and the added liqueur.

THE STATUE OF GENERAL GORDON AT THE BROMPTON BARRACKS, CHATHAM, ENGLAND.

THE MANUFACTURE OF PERFUMES AT NICE.

THE following is an extract from a report by her Majesty's consul at Nice upon the manufacture of perfumes in that district: "The art of producing scent is well understood in my district, but can only be acquired by long practice, by which alone the blending of the primary essences in proper proportions becomes thoroughly understood. The first process is the extraction of the essences by distillation. A large copper vessel or alembic is filled with water to about two-thirds of its capacity; the flowers to be treated are then introduced, and it is hermetically closed. It is then placed on a fire; usually, nowadays, gas or steam is used for this purpose. Steam is generated by this means in the cylinder, and is carried by means of a pipe into a second cylinder, which is constantly kept replenished with cold water, and is furnished with an overflow cock. The pipe, in its passage through this second cylinder, assumes the form of a spiral coil. This coil ends in a cock at the bottom of the cylinder, from which the volatile essence exudes drop by drop as the steam becomes condensed in its passage through the spiral coil. In this manner the essence is collected in a small glass vessel, while at the same time the water containing a small portion of scent, and which still remains in the alembic aforesaid, is itself perfumed, and becomes the rose water or orange flower water of commerce. All flowers are not susceptible of this treatment—some of them, such as jessamine, violet, cassie, tuberose, etc., containing no essence, have to be treated by a different process, which will be presently described. Of the flowers producing essences, the orange flower produces but 1 gramme of essence for 1 kilo. of flowers, or but one-thousandth part. This essence is styled 'neroli,' and is the principal essence produced in the district between the Var and the Italian frontier.

"The following table will show the proportionate yield of the different flowers:

Neroli.....	1,000	kilos. of flowers	1	kilo. of essence.
Rose.....	25,000	"	" 1	"
Geranium..	1,000	"	" 1	"
Mint.....	1,000	"	" 0·750	"
Orange leaf (bitter)...	1,000	"	" 1	"
Lavender...	100	"	" 0·500	"
Eucalyptus.	100	"	" 0·500	"

"The volatile essences thus obtained, combined and mixed together with a certain quantity of alcohol, are used in the preparation, and as the basis of eau de Cologne, toilet vinegar, lavender water, etc. There are two processes used for the purpose of extracting perfume from flowers which do not contain the volatile essence. The first may be described as the cold process and the second as the hot process. The former is generally used for cassie (*Acacia Farneriana*), jessamine, jonquils, tuberoses, violets, and some other flowers.

"Freshly gathered flowers are placed upon a layer of pure lard, a quarter of an inch in thickness, spread over a sheet of glass about two feet square, which is framed in wood and forms a kind of tray. These trays, sometimes some 40 or 50 together, are then piled upon one another; the flowers are changed every 12, 18, or 24 hours, according to circumstances, and the process is thus continued until the lard is sufficiently charged with perfume. Jessamine and tuberose are frequently changed as often as 50 times before the lard is considered to be sufficiently impregnated, cassie and violets from 30 to 40 times, and jonquils about 20 times only. The fat thus obtained can be packed in air-tight tins and conveyed anywhere.

"When the hot process is resorted to for the purpose of obtaining the impregnated fat, 20 kilos. of grease are placed in a copper vessel, together with some 5

kilos of flowers; the vessel is then placed over a slow fire, and the contents are well stirred. After allowing the compound to boil for 10 minutes, the vessel is left to cool for some hours; an additional 5 kilos. of flowers are then added, and the process is repeated until the fat has absorbed the requisite amount of perfume; the hot liquid is then poured through a sieve, and the greasy flower-paste that remains is subjected to hydraulic pressure. It is in these two ways that the 'pommades' of trade are produced.

"From these 'pommades' perfumed and alcoholized liquids are extracted by means of grain spirit, and also by spirits of wine; these are the 'extraits' of trade, and it is by the judicious blending of the different essences and concentrated perfumes, obtained by the processes above described, that the numerous scents are produced.

"The principal 'perfumeries' of my district are situated at Grasse, but the Bermonds and Lhermines of Nice are well-known houses; the latter of which appears to be at present the most important manufactory in Nice and its neighborhood."

ACADEMY OF SCIENCES BUILDING, SAN FRANCISCO.

The late James Lick, among his many other benefactions, deeded to the California Academy of Sciences, some time before his death, a fine building lot on Market street, near Fourth.

This is 80 ft. front; it is 195 ft. deep on one side and 275 ft. on the other, being triangular at the rear end, where it adjoins the lot of the Society of California Pioneers.

The Academy of Sciences, being residuary legatees of the Lick estate, will receive some $300,000 or $400,000 in money on the settlement of the estate, and have obtained from the Lick trustees sufficient money to put up a very fine building, which is far the best for scientific purposes on this side of the continent. In fact, the academy will shortly be better housed than any similiar institution in the United States, thanks to the liberality of Mr. Lick.

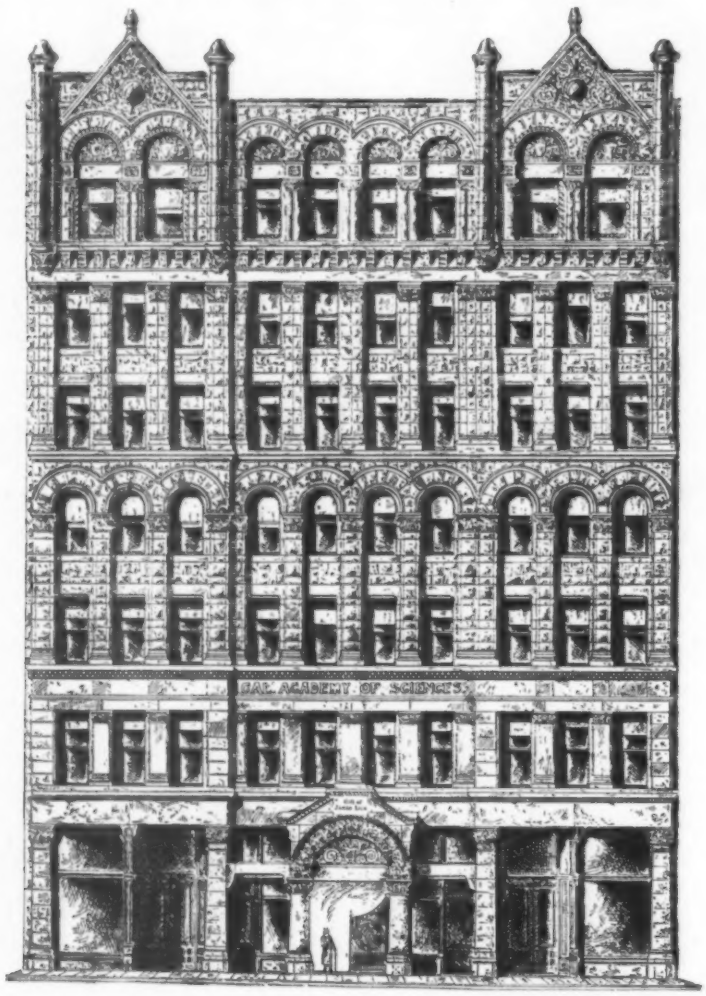
We present an engraving of the new building, now rapidly approaching completion. It was designed by Percy & Hamilton, architects, and is seven stories, or 112 feet, in height. The building almost covers the entire lot, the exception being in the rear, where the sharp angle of the triangle is cut off and the back wall of the new building forms an acute angle with the existing oblique wall of the Pioneer building, in order to permit of the insertion of windows along that side.

The entire front is of stone, for the first two stories gray granite, and for the upper ones sandstone in two colors. The accompanying sketch shows the character of the frontage. The ornamentation in the gables and other parts is in keeping with the objects for which the building is intended. Rich carvings at the cornices, pillar caps, arches and pediment add greatly to the appearance of the building and make its substantial and desirable stone front a thing of architectural beauty. The four walls really inclose two separate buildings, one an income-paying property of stores and offices, seven stories high, and the other behind it devoted entirely to the needs of the academy, a six-story structure. Immediately behind the rear wall of the front building is a light well, 27 feet in width and as long as the lot is wide, 80 feet, rising from the second story up, still more effectually marking the separation of the two buildings. The main and only entrance to both front and rear structure is from the Market street front by a lofty, wide hallway, dividing the ground floor of the seven-story building into two parts for its entire length. The front building stands on the lot 80 by 88 feet, and will consist of stores and offices.

There are four stores, a large and small one on each side of the entrance, the former being 20 feet wide in front and 31 feet in the rear, and the latter of small depth with a frontage of about 13 feet each. The offices of the upper floors are fitted as most modern offices are, electric wire bells, calls and all other customary conveniences being introduced in their proper places.

The finish is wood for the wainscoting of the corridors, doors and windows, as well as to some extent inside the different apartments. The partition walls inside the second story are of what is termed "slow-burning" or fire-resisting material.

The hallway on the ground floor is 12 feet wide, the entrance archway being elaborately carved and supported on double columns of polished granite, affording great depth and an imposing appearance. The floor is laid in colored tiles of picturesque design. The wainscoting for a height of ten feet is of marble, and from that height to the ceiling the walls are of different colored patent bricks with small arches and pilasters in relief. On the right side of the hallway, a marble and iron staircase six feet wide rises, and opposite it is a passenger elevator. The entire shaft is built in with brick walls and fireproof casements, lighted by a well on the west side, covered by a glass skylight at the top of the shaft. A large light well over the staircase and hallway affords abundant light to both on every story. The fire hose closets are arranged on each floor near the elevator shaft, and the sanitary arrangements are also complete on all seven stories.



THE NEW BUILDING OF THE CALIFORNIA ACADEMY OF SCIENCES.

From this description it will be seen that the front building is a first-class store and office structure, of which there are many similar ones in the city. The rear building is of more interest to the majority, and will be a museum and scientific repository equaled by few in this country. While the front structure is to be fire-resisting, the rear one is absolutely fireproof in the fullest meaning of the word. There is no wood whatever used in its construction, except for the mere floor coverings in the upper part of the building. The ground floor is devoted to an assembly hall, the second to a museum, and the four upper floors are merely galleries running round all four walls and connected by an iron staircase from the second story up.

The approach to the academy is made a specially attractive feature. At the end of the main hallway a bold arch resting on double columns of white marble opens on to a low flight of white marble steps rising to a spacious landing, at the end of which a shrine-like niche forms a fitting receptacle for a bust or medallion of James Lick, with a record of the bequest beneath it. The balustrade, all of marble, is richly carved. It is bold in design, in keeping with the Romanesque exterior, and is one of the handsomest staircases in the country. From the landing another short staircase rises on the left to a second landing, opening on the museum floor, all the stairs being of marble. The space occupied by these stairs and landing is canopied by a beautifully finished glass roof under the dividing light well, behind the partition wall of the buildings.

The lighting of this rear building has received special attention—on the Pioneer place, or east side, a frontage of 50 feet; on the west side, a light well, 50 feet long, corresponding with that frontage; on the north the well 80 feet long; on the south the Stevenson street frontage; and the skylight on the top of the building, 70 feet long, all contribute to this end. The galleries, corridors and passages will thus be flooded with light at all times.

Passing round the foot of the staircase on the ground floor and to the right, ingress is afforded to a broad marble corridor which surrounds the assembly hall on three sides. This hall will stand of itself inside the building and have a sloping amphitheater of seats, with a raised platform at the south end. The roof of the hall, which forms the museum floor, is to be Romanesque, as well as all of the decorations. Heavy columns and boldly projecting beams forming deep panels in the ceiling, fireproof walls lighted by stained glass side windows looking out on the corridors, and doors handsomely carved, all contribute to make the temple of science strikingly handsome.

On the same floor at the left of the hall, and along the slanting wall of the Pioneer building, there will be a good sized reception room for smaller meetings, and behind it, as well as along the Stevenson street side, space for toilet rooms is to be provided.

The museum and galleries forming the five upper stories need no special description, the chief point in their design being their fitness for the uses to which they are to be put. The galleries are to be 20 feet wide all around, carried on columns continued from the lowest story through to the roof. The estimated cost of the entire building, front and rear, is $280,000.

It is a matter of pride for San Francisco, one of the youngest of the large cities of the United States, to have so fine a building devoted to science. With the money that will come in due time from the Lick estate and the income afforded by the store portion of the building, the California Academy of Sciences will be one of the wealthiest private institutions of the kind in the Union. Its members have passed through many struggles of a financial nature since its organization in 1853, but on the completion of the building the institution will be on a footing which will greatly enlarge its usefulness.—*Min. and Sci. Press.*

METALLURGICAL USE OF FLUORSPAR.

Fluorspar was, until the commencement of this century, considered an indispensable flux; it diminishes the loss of metal, and was then the only energetic means to reduce the melting point of slag from ores carrying a high percentage of clay and zinc. Without fluorspar very refractory ores could not be smelted at all. Gradually, however, as the blast furnaces and smelting apparatus were improved, fluorspar was superseded by lime and other cheap fluxes, but of late its use has been reintroduced into nearly all branches of metallurgy. While fluorspar is regarded as a mere means to unite with excessive silicic acid, the possibility of its adoption is surprising, in view of the fact that the cost of fluorspar is six to seven times greater than that of limestone, while the formulæ for fluorspar and limestone, respectively

$$2CaF^2 + 3SiO^2 = 2CaSiO^3 + SiF^4 \text{ and}$$
$$3CaCO^3 + 3SiO^2 = 3CaSiO^3 + 3CO^2$$

show that the quantitative economy in fluxing with fluorspar compared with limestone is as 156 to 300. The fact is, however, that one part of fluorspar goes farther than ten parts of limestone. The former is especially effective in reducing the quantity of fuel; it forms two parts of slag where limestone forms three, and it forms possibly also fluorsilicate, whereby heat is likely to be liberated. While the rather high price of fluorspar prevents its use in the production of ordinary white and gray pig iron, it has proved a rapid and energetic solvent in blast furnace work, where it is blown in as powder through the nozzles. In making silicon iron, fluorspar plays a more important part. A ferro-silicon iron, with 10 per cent. silicon, made specially in Upper Silesia, is almost indispensable for works that make very tough, deep gray castings. This ferro-silicon can be obtained in any ordinary blast furnace from any silicious iron ore if it is only fluxed with fluorspar and the slag is strongly basic. The fluorspar reduces the silicon energetically; at all events, fluorsilicon is formed, which is reduced to silicon by the hydrogen contained in the furnace gases, and possibly also directly by the coke. It does not seem impossible that the greatly increased price for coke will result in a reintroduction of fluorspar as a fuel-saving flux in the manufacture of foundry pig, particularly as even a very small quantity of fluorspar, added to the charge, at once raises the product to No. 1 deep gray pig, rich in graphite.

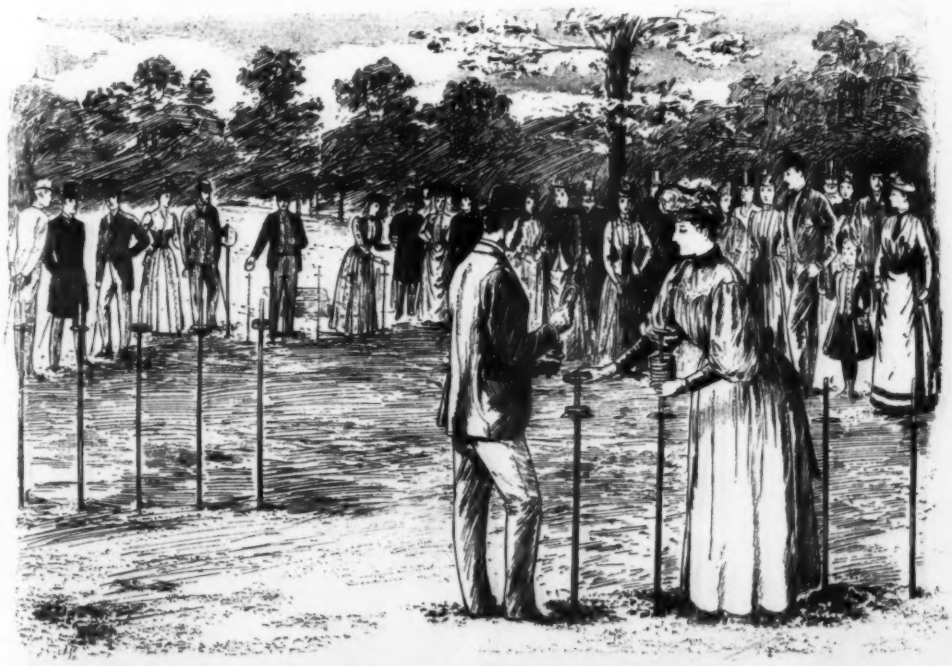
The remarkable property of fluorspar, that it facilitates the reduction of the most different bodies—a property common to almost all the fluorides—makes it a valuable flux in the production of spiegeleisen. It has long been known that fluoride of manganese, as well as a mixture of a manganese combination with fluorspar, can comparatively easily be reduced to metallic manganese by means of sodium. This reaction served Brunner in his successful attempts, the first ever made, to produce metallic manganese in large quantities. The modern application of this method to the blast furnace substitutes carbon for sodium. A highly basic slag, rich in fluorides, seems nearly indispensable for the production of a rich ferromanganese in the blast furnace. The property of fluorspar, to carry phosphorus into the basic slag, has never been of special importance as far as pig iron is concerned, but it is utilized by the Krupp and Rollet methods of dephosphorizing pig in the basic-lined cupola furnace. While, at all events in the blast furnace process, the property of fluor calcium to form an easily melting slag with phosphates is of some importance, fluorspar, in the process of purifying the pig iron, serves probably only as a flux for the highly basic lime slag saturated with phosphorus. In the Thomas process too, and even in the Bessemer converter, fluorspar is in recent practice being added in small quantities for the purpose of concentrating the slag and reducing the loss of

metal; very great care, however, is needed to prevent such a slag from attacking the acid lining. It is also said that in puddling in the various steelmaking methods and in the Siemens-Martin process fluorspar is added, partly as a slag-forming flux. The details are, however, not known.

In foundry work, it is an astonishing fact that limestone, which, because of its cheapness, superseded fluorspar, of late is losing ground to the latter. The limestone flux in cupola furnace work serves only to slag the ashes of the fuel, the sand adhering to the pig, etc., no chemical effect on the iron being intended. But the fluorspar affects the iron noticeably, keeps it gray and soft by keeping the silicon as an alloy, while a limestone flux favors the tendency of the silicon to slag. Besides, fluorspar carries some phosphorus and sulphur into the slag. Fluorspar makes it possible to melt inferior kind of pig iron and a higher percentage of scrap. But, strange enough, practice has shown that too much fluorspar is rather injurious than advantageous; one reason for this being that the manganese contained in the iron is thereby prevented from slagging. The quantity of fluorspar which is added to 100 kilogrammes of pig iron to be remelted is one-third, or, at the most, one-half, kilogramme. The improvement of the product caused by this flux is specially manifest in the improved cupola furnaces, particularly the Herbert's furnace, which has much facilitated the utilization of inferior iron for soft castings. The property of fluorspar to protect manganese does not seem favorable enough to offset the injury due to its silicon-reducing power. Its use would, at least, require melting in a basic furnace or as cold as possible. As the small quantity of the phosphorus and sulphur which is contained in Swedish charcoal iron is almost entirely carried off in the comparatively acid slag by fluorspar, this is of prominent importance for the treatment of very pure qualities of iron.—*Chemiker Zeitung.*

THE NEW GAME OF "COLORS."

THERE are always a number of people who, while they like the mild excitement of a garden party, and enjoy the attention they receive, yet do not care to go in for the somewhat boisterous exercise of lawn tennis or the now almost obsolete prosiness of croquet. For the benefit of such and also for the advantage of those whose age stands in the way of their joining in the energetic games of athletic youth, a new game has recently been invented by Mrs. A. Hartshorne, of Bradbourne Hall, Wickworth, near Derby. "The Colors," as this new game is called, is not quite so simple as it looks. It may be played by four or eight players, and was described as follows to a representative of the *Pall Mall Budget* by Mr. A. E. Prosser, of Pentonville Road, who has obtained the manufacturing concession from Mrs. Hartshorne. "Suppose we have four players, the materials for the game are four sets of five posts painted red, white, blue, and green. Each player has a little rack on which she or he carries eight rings, two each of the same colors, and two small flags bearing the letters 'R.' or 'L.,' signifying right or left. There are also flags painted black to indicate a miss or 'fault.' The court should be sixty feet long by thirty-six feet wide. To arrange the ground the posts are planted in sets of five each post two feet six inches apart from its neighbor, in a figure which would form a cross, the first or starting set being at one end of the ground, the end or finishing set at the extreme end of the court, exactly opposite the start, and the side sets in the middle of each side of the court. Each player being furnished with his complement of eight rings, which have previously been shaken up in a bag, two partners stand on each side of the starting set of posts facing each other. The whole object of the game is to get rid of the rings in such a manner that they retain their proper sequence on the posts. There is no throwing or running. The players walk leisurely from set to set, deposit their rings if they can, and then walk on to the next set of posts. One player may get rid of a ring by placing it on his partner's ring, and any player may play two rings following if possible. There is no hurry or scurry, but there is a certain amount of science in the game, and, of course, it may be varied in many ways. I think it will become popular to a certain degree, because it requires no exertion. It may be called the quadrille of garden games. It will never in any way interfere with tennis, because it appeals to totally different people from tennis players, but there is plenty of room for it, and it certainly is prettier and more interesting than croquet, though it seems so simple." The new game was played the other afternoon in the gardens of the Inner Temple by a number of trained players, before a party of specially invited guests.



THE NEW GAME OF "COLORS."

A BIRD AQUARIUM.

THE accompanying engravings represent a bird aquarium which is of very simple construction and well calculated to awaken curiosity.

FIG. 1.—BIRD AQUARIUM.

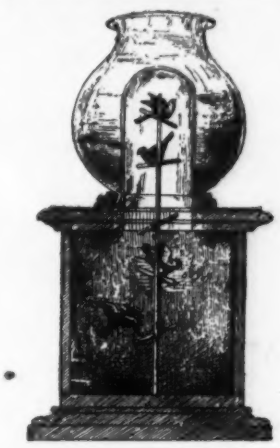


FIG. 2.—SECTION.

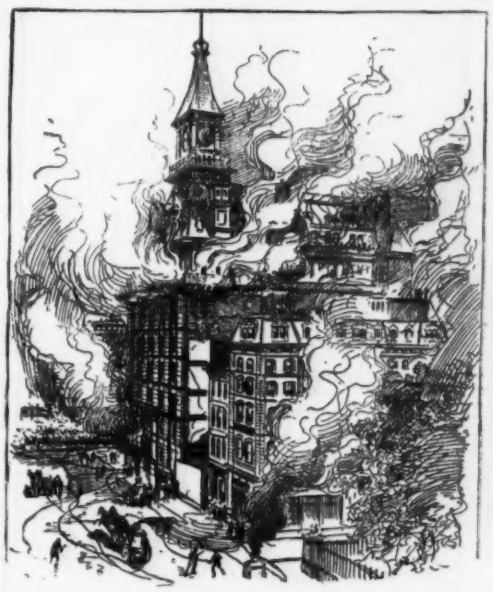
It consists of a glass globe in the bottom of which there is an aperture wide enough to permit of the introduction of a glass cylinder of quite a large diameter and closed at the top. The lower part of this cylinder enters a cage which is concealed by the stand upon which the globe rests. The external portion of the cylinder is hidden by stones and shells. The cylinder, at the point where it enters the globe, is fixed to the latter with cement.

If sufficient water is put into the globe to cover the cylinder entirely, and care is taken to arrange the affair at the level of the eye, we shall very easily obtain the illusion of a medium in which birds and fishes are living together.

The arrangement may be varied in many ways (the principle always remaining the same) and the most varied effects be obtained.—*Les Inventions Nouvelles.*

THE RECENT FIRE IN THE WESTERN UNION BUILDING, NEW YORK.

IT has been long since a fire has happened in New York City which has excited so much public interest as that which recently occurred in the great ten-story building of the Western Union Telegraph Company, at Broadway and Dey Street. This was due not especially to the direct property loss caused, for it is now thought that this will not exceed $200,000 to $250,000, but chiefly to the great interruption in telegraphic communication caused by the destruction of all the instruments in the company's chief office and of many of the wires leading to it, as well as to the prominence of the building and



THE FIRE IN THE WESTERN UNION BUILDING, NEW YORK, JULY 18.

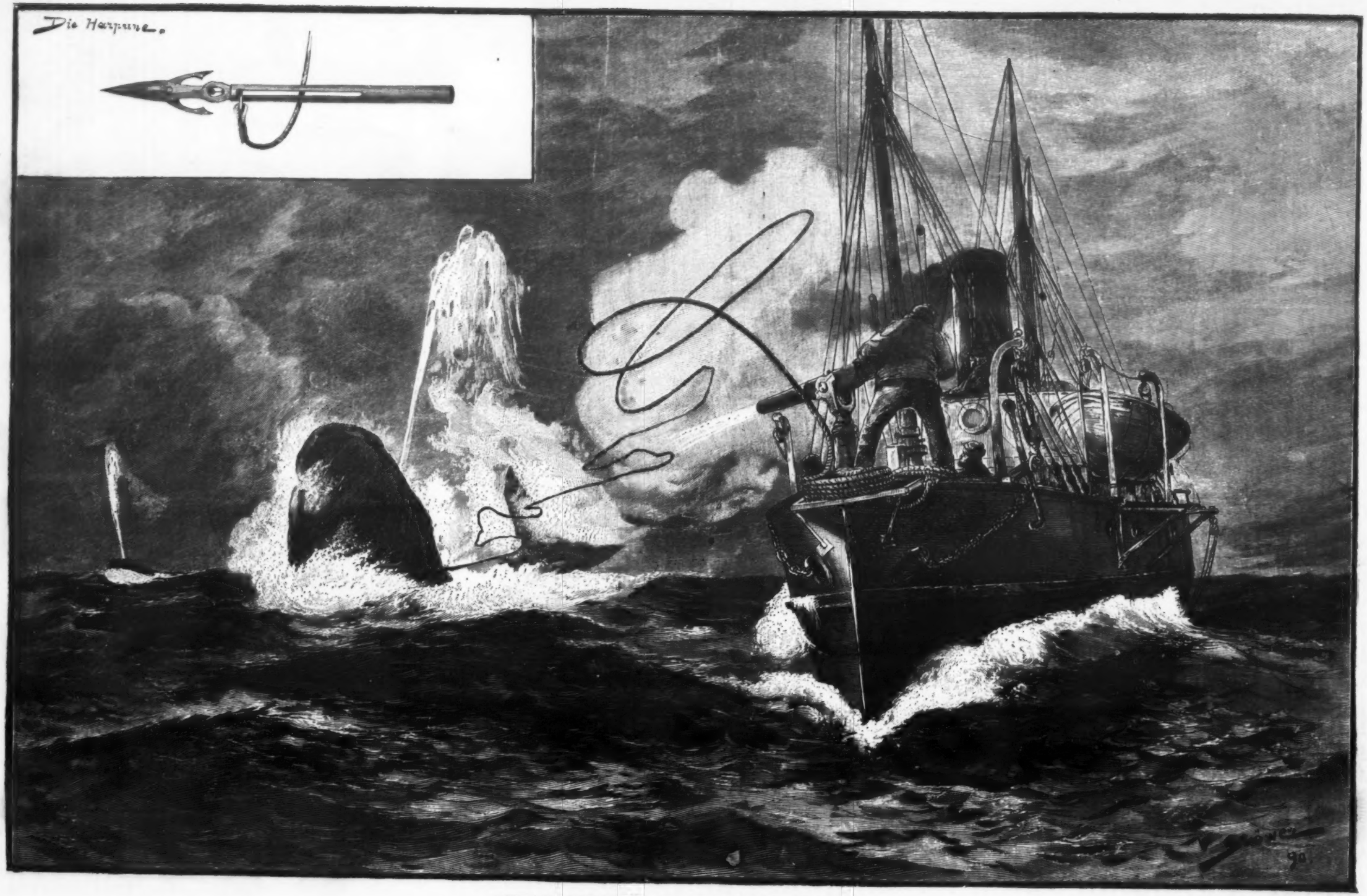
the fact that it had been described as one of the strictly fireproof structures of the city.

The fire was first discovered in the battery room on the sixth floor. It is believed to have been caused by the crossing of an electric light wire, somewhere, with one of the company's telegraph wires, along which a slight flame was noticed creeping, feeding upon the insulating material. Two men who were in the room hastily seized hand grenades and broke a number about the place, but without avail, the flames spreading from wire to wire throughout the room with such rapidity that the alarm was quickly given to the thirty-odd persons in the operating room on the seventh story, and hose was got out and attached to the hydrants fed from a tank above. Some of the hose, however, was old and rotten, and burst, the fire increased in volume, and finally messengers were sent to give the alarm to the department; most of the telegraphers made their way by the stairs and elevators to the street, some few, however, who lingered too long, having to resort to the window ledges and the balcony outside of the upper

floors, whither fled also a half dozen or more of the female servants in the restaurant who had sleeping rooms under the roof.

Meanwhile from the street the smoke had been seen and alarms rung in from several boxes, and a few minutes later the engines and trucks were on hand and lines of hose were being run up, through and over the comparatively low buildings adjoining on Dey Street and Broadway, as well as through the burning building itself.

The scene, as a *Fire and Water* man viewed it at a few minutes past seven o'clock, was an impressive one. From each window of the seventh floor of the enormous structure belched volumes of fat, black smoke, rolling upward over the wide cornice and balcony until it hid the whole face of the building above it; then suddenly from a window on the southwest corner of the building a tongue of flame shot out over the heads of



STEAM WHALERS IN THE NORTH SEAS.

the crowd in Dey Street, and a few moments later the fire was blazing out fiercely from all sides.

The peril of the men and women on the roof was quickly perceived. The truck men quickly sent up ladders to the roof of the next building in Dey Street and rescued several persons. Far up on the balcony on the north side of the building, however, eight or nine others, making signs for help, stood in full view of the crowds which filled Fulton and Vesey Streets and Broadway, about St. Paul's churchyard. But the firemen were working with a will. An extension ladder was raised to the roof of the next building on Broadway, but it would not reach the balcony, and the flames from the windows prevented the use of scaling ladders. There was one more resort, however—the life-line gun. This is a short Remington carbine, carrying a 44 caliber blank cartridge containing seventy-seven grains of powder. The stock of the gun is solid steel, made thus heavy to help counteract the heavy recoil. The barrel is twelve inches long. The projectile is not a bullet, fitting inside the barrel, but a steel sleeve nine inches long, with a solid conical point. It fits over the muzzle and barrel. A slender line 500 ft. in length is fastened to this projectile. The line is coiled in a tin tub, from which it renders freely.

One of these was brought into play and a line cleverly shot up among the group above, when a heavier line was drawn up and made fast. There was great cheering at this from the crowds below, but the line was, after all, not destined to be used, for before it could be brought into play the firemen had managed to fight their way through the building to the roof, and deeming it safer, took the party safely down the stairs, through smoke and fire, while a hose stream was played on them.

All the inmates having escaped, undivided attention was given to quenching the fire. Within the building it was fought from below and driven gradually upward, while from without heavy siamesed streams were poured into the windows from the surrounding roofs on Dey Street and Broadway, until at about ten o'clock the fire was brought under control, after having gutted the sixth, seventh and eighth floors and tower. In the operating room the destruction was complete, the great switch board and the 1,600 instruments being entirely destroyed.

Too much praise cannot be given to the New York firemen for their work at this fire, which was characterized by promptness, skill and coolness.—*Fire and Water.*

STEAM WHALERS.

IT is now a well known fact that steamers have taken the place of sailing vessels in hunting whales, and that a cannon harpoon is now used instead of the hand harpoon of former years. Hunting of whales by means of steamers is most actively pursued on the Norwegian coast, and the principal station for hunters is Hammerfest. Steamers of medium size and strongly built go out to sea from this station, and remain for days in search of whales. The moment a whale is sighted, everything on board is made ready for the attack. The cannon in use, from which the harpoon is shot into the whale, and which was constructed by Captain Sven Foyn, is placed on the bow of the steamer over the forecastle.

The harpoon consists of a long shaft, a ring to which is attached the towing line, and a sharp point. In this point is a grenade filled with powder, which explodes in the body of the whale by means of the striking together of the two barbs of the harpoon. The death of the whale is thereby quickened and rendered more certain. The line, which is made from the best quality of hemp, is fastened to the ring on the harpoon, and a sufficient quantity is coiled for shot range. The line lies on a platform directly under the cannon, and, by means of a guide pulley, it is let out to follow the whale when he dives, for he seldom dies immediately. In his rage from pain he rushes in all directions, dragging the steamer after him in his dying agony. This is the dangerous time for vessel and crew. The engines are reversed and stoppers are placed on the sides of the steamer under the water, so as to offer more resistance to the whale's strength.

The crew then wait until the whale is tired and dies. By means of a steam windlass the body of the whale is drawn to the surface, and attached by hawsers to the steamer's side, and thus towed into port.—*Illustrirte Zeitung.*

DISTEMPER.

MR. EVERETT MILLAIS, son of the artist, has been investigating the origin of the disease of the dog tribe which is commonly known as distemper, and he believes that he has succeeded in establishing the identity of a bacillus which is the cause of it (*Brit. Med. Jour.*) The disease is infectious, and after exposure to infection an incubative period of variable duration follows; the symptoms which then appear are dullness, loss of appetite, and fever; the nose at the same time becomes hot and dry, and a husky cough, constipation, or diarrhea is commonly present. The eyes and nose now discharge freely, the fluid being at first watery, but purulent later on. Finally, the animal emaciates rapidly, while the coat becomes hard and staring. In about three weeks, should no complication ensue, the dog begins to regain condition and recovers. Unfortunately, complications generally do supervene, for few cases occur in which bronchitis is not a symptom. Pneumonia carries off a large number of those attacked, while jaundice, fits, and diarrhea account for the death of many others. As sequelæ we find chorea and paralysis.

The mortality is very high, and 90 per cent. has been given as the loss from this disease. It is nevertheless doubtful whether the mortality is really so high, as it is a notorious fact that mongrels are peculiarly exempt from malignant distemper. In well bred dogs, however, 90 per cent. fairly represents the average of fatal cases.

The author, in the experiments made to discover the pathogenic micro-organism, inoculated several tubes of gelatine with the mucus obtained from dogs suffering from the disease. He succeeded in infecting puppies with the disease by inoculation with cultivation of the eighth generation. The cultivations showed two distinct bacilli, A and B, as well as a large number of micrococci. Bacillus A and the micrococci were found not to produce distemper, but bacillus B produced the diseases within the usual period. It was observed, however, that in the latter case the distemper produced was of a very mild description, this being due to the fact that the cultivations were made at a temperature of 60° to 70° F., which is much below the temperature of the dog (101·5° F.) The result of this was that the virus became attenuated, a fact which was experimentally proved by the inoculation of two valuable blood hound puppies, and they had very mild attacks, whereas it is the nature of bloodhounds to suffer severely when the distemper is on them. After a week the puppies were inoculated with a pure culture of the specific bacillus B, and to insure infection they were placed in a kennel recently occupied by dogs suffering from distemper, but they were now proof against the disease. The experiments were repeated on other dogs, with practically similar results, and the author arrives at the conclusion that the bacillus is the primary cause of distemper and the micrococcus the cause of the complication pneumonia; while the two when combined produce pneumonic distemper. In the fatal cases it is pneumonia which is the immediate cause of death.

BOMBONNEL, THE PANTHER HUNTER.

BOMBONNEL, the celebrated panther hunter, died recently at Dijon, aged 74. In his youth he emigrated to Algiers with the firm intention of hunting panthers, and he gained a reputation in this dangerous sport that made dim that of Jules Gérard, the killer of lions,

BOMBONNEL, THE PANTHER HUNTER.

for hunting panthers is equally dangerous. Bombonnel had wonderful skill, and generally struck a panther in the head or heart with his ball; sometimes, however, he did not succeed in killing the animal at first shot, and in such cases the struggle was fearful, for the hunter was then reduced to the necessity of defending himself by means of a knife. Bombonnel led this kind of a life for many years, being often accompanied by his wife. When he grew old, he retired to Dijon, and wrote a narrative of his adventurous life.—*La Science Illustrée.*

THE PTEROPUS OR FLYING FOX.

By NICOLAS PIKE.

IT is in the family *Cheiroptera* or bats that we find the only indigenous animals of Mauritius, and the principal ones are in the genus Pteropus. There are two species, the *P. Edwardsi* or *edulis* and the *P. rubicollis*. It is principally of the former I shall write in this article. These large bats have many representatives in Africa, Asia, Polynesia and Australia. In Europe only fossil ones are found. The two species above mentioned are, I believe, peculiar to the islands of the Indian Ocean. I had many chances of studying their habits in Mahe, one of the Seychelles group, and also when camping out on my tour round Mauritius.

These animals are the true *rousettes* of Buffon and other French writers, and it is quite certain they were abundant even in the time of the earliest navigators, for there are rude drawings of them in the quaint pictures of the old Dutchmen who landed here. Marvelous stories were prevalent of these giant bats, and they were accredited with terrible vampire propensities, but their mouths are quite unfitted for such work, and the most I could find out about them was their too great love for fruit. All the family have four great canine teeth, but the molars of these frugivorous bats differ essentially even from the insect-eating ones, the crowns of the former being comparatively blunt and hollowed out or grooved lengthwise, while those of the latter are shorter and sharper, and beset with points. The tail in the insect eaters is well developed and very small or absent in the frugivorous. The tongue is capable of considerable extension, covered with strong papillæ, and ends in a sharp point, admirably adapted for sucking up the juices of aloes and other flowers.

The bodies average from 12 to 14 inches long, but the great wings grow to three and four feet when expanded, and are very strong to sustain the strain of long flight and the heavy bodies when suspended in sleep. The general color of the older ones is dark, and shiny on the head and neck, wings and claws black, and the rest of the body a rusty brown. The young are lighter, and some have even a yellowish tinge on the thick, soft fur.

As a rule, but one young is produced at a birth, though twins are sometimes seen. At this time the female is very shy and savage, and soars high in air when abroad. The males quarrel violently, but, strange to say, all disputes are settled away from home, and their "camps," as the Creoles call their retreats, are always quiet. When fighting, they utter a sort of bark like a poodle dog, and growl at each other; and all, when disturbed, give a short, sharp squeak. When about to become a mother, the female seeks the deep recesses of the forest, and chooses some hollow trunk of a tree, and a warm nest is made of leaves, moss, or any handy material. When she sallies forth for food, and the little one is strong enough, she carries it with her clinging to her breast. She never abandons it till it can forage for itself, and defends it viciously if interfered with, for she can bite sharply, and her great claws are formidable weapons of defense or offense.

I will give my first experience with these animals, when in Mahe. One evening I was resting close to a large aloe nearly 20 feet high, surmounted by its grand crown of fragrant yellow flowers. I was astonished to find the blossoms dropping all over me. Looking up, I saw some flying foxes hard at work tearing the flowers to pieces to get the honey that lies at the base, breaking off whole bunches in their eagerness. I remained quite quiet to watch them, but so busy were they I was unnoticed. When the flowers grew scarce on the boughs they circled round and round quite close to me, but as silently as so many humming birds. I could have knocked them down with my cane, as they examined every fallen flower, but as study was my object then, they were unmolested. When satisfied they went to another aloe, but as I followed through the dry brush, I scared them and they took flight.

I was determined to find the haunts of the numbers of bats I saw fly past our camp every night, so dispatched a trusty Mozambique to explore the forest, with the promise of a reward if he succeeded in finding their retreat, and gave him orders to search the darkest part of it, where I was aware they congregated. He returned about sunset of the same day with glowing ac-

counts of what he had seen, but it was "Far away, master, near the sun," meaning due west. I was pleased, and gave orders to break up camp on the morrow, and off we marched. It was lucky the Mozambique had blazed the trees on his return, or we should surely have lost our way, over hill and dale, and through jungle and swamp, but he led us well. We got there tired enough, but just in time to see a large number of the animals preparing to leave their resting places, soon after sunset.

They hang by the strong hooks on the top of the wings to the branches of trees, hiding the head in a fold while they sleep. Most were still hanging in every direction, but when ready to move they dropped a few feet from the bough, and then they expanded their wings and flew away. We pitched our tent where we could command the whole situation and could see all we wanted, and I gave orders to be woke at daylight to see them return.

I was scarcely out and about when on came the flying foxes, in twos and threes, one after the other, till there were hundreds hanging head downward either by the claws or winghooks to the highest branches of the tall trees. Some of the females had young ones, visible when they were flying, but as soon as they were settled for the night, they were folded in the mother's wings. The sight was singular and to me a memorable one. There in the dense forest of large trees were four or five hundred of these animals hanging above me in a space not over a hundred square feet. It had something comical in it too, for looking up at them casually, they seemed, in the half light, to be so many large black wine bottles hung by their necks.

During the day our presence did not at all disturb their slumbers, but toward evening I determined to have a shot at them for specimens, and also for food for my people. Where there is plenty of fruit near them they grow very fat, a layer of white grease covering the whole body between the skin and muscles. They are eaten by both whites and blacks, but they have rather a strong taste, though the flesh looked tempting.

I selected a group where they hung thickly together and killed six. All fell to the ground dead but one, that clung tenaciously to the branch, high out of our reach. The rest rose up in terrible confusion at the report of my gun, and it took some time for them to recover, when they sailed away far out of our sight. From their large numbers they are quite dreaded by the poor planters. When they find out a patch of banana trees they flock to it, strip off the skins of the fruit and devour incredible quantities before they can be routed. Also in the groves of cacao trees they seem to know when the fruit is ripe before the owners do, and make a dead set at it. They open the long pods of the cacao, pick out every nut, and in one night do immense mischief, so that between bats and rats there is little hope of a harvest.

In the districts of Savanne, Black River, and the Chamarel, in Mauritius, these bats are still very numerous, and they make bad neighbors to the market gardeners who trust to their litchis and bananas to help pay expenses, small profits at that, as they have so far to go for a market. With the utmost vigilance they can scarcely preserve their litchis, that queer, delicious Chinese fruit, that looks like an egg that has lost its shell and found a rough, tubercled, red one, from the marauders, for they return again and again, even after losing numbers shot down.

Among those I shot near Chamarel was a good sized female, with her young one still clinging to her as she fell, and quite unhurt.

I brought it home, and though not half grown, it was very active and savage, biting at everything within reach. I put it in a cage, but it was two or three days before it got used to the situation and took food. I fed it on all kinds of fruits in season, and it was especially fond of half ripe Badamier nuts. It grew and thrived, and I kept it for about four months. I let it out of the cage and put up a line where it hung all day, but uttered a sort of mournful cry when approached. At night it was very restless, flying all round seeking to escape. It got tame enough to feed from my hand, when a servant left a window open one night, and I lost my pet.

On another occasion I had two young ones brought to me, found hanging on a tree. I succeeded in taming them after a time, so that they followed me about and crawled on my desk to be noticed while I was writing, and they let me stroke them on the head and back. If a stranger came in, they hid in a corner till he was gone, and then they came back to me When they wanted food they gave a sort of squeak, raising the head and looking at me with their black, glistening eyes. The food was generally taken while hanging by one of the thumbs. They could run over the floor pretty quickly and rise easily from a flat surface when about to take flight. At night I could do nothing with them. They circled ceaselessly round the room, uttering mournful cries, nor do I think they could be thoroughly reconciled to confinement. Their nocturnal habits are too strong to bear it. I had to part with my bats, having only half succeeded in taming them, and I never heard of any one who did more. I shot several in the Savanne district. One I measured was 3ft. 10 in. across the wings, 11 in. the length of body, the toes 1¼ in., including the strong claw; the fore arm 7½ in., head 3½ in. and ears 1½ in. It was the largest I ever shot, but they speak of one in some museum measuring 16 in. in body and five feet over the wings.

The *prubicollis* does not grow nearly so large as the *edulis*. The fur is very thick and rough, of reddish hue, with a dark patch on the back, the head and neck of a light yellowish color and the wings dark brown. The head and ears are round, and the short, thick fur standing up straight over the head gives the creature a monkeyish look, increased by the keen glittering eyes. The habits of this bat are so nearly like those of the *edulis* that the description of one will serve for both.

APPARATUS FOR COOLING MILK.

MILK, as well known, when put into a closed vessel at an elevated temperature, quickly undergoes an alteration. So upon all large farms a trial has been made of numerous systems for the production (at the moment of this operation) of a cooling that may permit of the carriage of milk in boxes to the centers of consumption.

We present engravings herewith of two such refrigerators, as constructed by Mr. Brehier. The first is very simple. The cans are placed in a double bottomed iron plate cooler (Fig. 1). The cold water enters the double bottom, flows into the cooler through apertures in the iron plate, and after circulating in every direction around the cans, runs out, through apertures at

FIG. 1.—COOLING MILK IN CANS.

the top, into a gutter, and thence escapes through a waste pipe. This is the system of cooling in cans.

The other system, called direct cooling, is a methodical process quite like the Lavelle process employed in distilling.

The milk is put into an upper reservoir (Fig. 2), and flows thence to a slightly inclined double pan provided with projections that retard the circulation. From this pan it flows to a second one inclined in the opposite direction, and so on to the bottom, where it is received in cans.

The cold water enters the first double bottom at the lower part, rises thence into the second, and so on, until it reaches the upper part, where it flows out

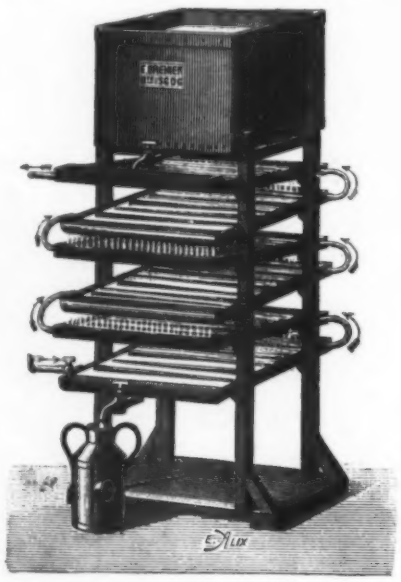


FIG. 2.—DIRECT COOLING OF MILK.

through a waste pipe. The circulation of the liquids, therefore, takes place in opposite directions, and the coldest water is in contact with the milk already cooled. This is the process that permits of the best utilization of the refrigerant power. Besides, the apparatus takes up less room than the other, for the same bulk of cooled milk.—*Les Inventions Nouvelles.*

BUTTER MAKING.

By JAS. W. ROBERTSON, Dairy Commissioner.

FAT GLOBULES IN MILK.

WHILE her milk is being elaborated by a cow, the ends of the cells which line the inside of the milk ducts and vesicles in her udder seem to enlarge. Each one forms a small globule, and when that is perfected it drops off into the serum of the milk. Each bud or globule, so formed, is a globule of fat; from them is made all the butter from cows' milk. These tiny buds of fat seem to grow on the surface of the cells, partly by the destruction of the cells, and partly by conversion of some of the substance of the blood into fat. They trickle down in and with the milk, and are held in suspension, not in solution, as are the other solids in it. They mostly come during the latter part of the milking, probably because they do not move so quickly or easily as the liquid part of the milk. The foremilk is thinner than the strippings, because the globules of fat do not free themselves from the internal linings of the milk ducts so quickly as the liquid of the milk. If one finds, sending milk to a cheese factory, a man who is of so modest and retiring a disposition that he will not keep at home for table use a quantity of the average milk given by the cow, but always and only the last quart, his modesty should not be respected or trusted too far; such modesty may not be found compatible with honesty. The condition of the cow's blood and her nervous system very largely affect the quality of the milk she gives. Bad feeding, foul water, or the absence of salt will induce in the cow a condition in which she will not yield good milk; a similar condition, with its consequent effects, may be caused by neglect, exposure, abuse, or excitement. A cow has a peculiarly delicate organization, and must be handled with kindness, and any man who abuses a cow beats out the profit, for she will pay him back by giving less milk, and that of a poorer quality. The globules of fat, before mentioned, are so numerous that in a thimbleful of milk there will be found millions of them. It is estimated that there are at least one thousand millions of them in every cubic inch of milk. From these specks of fat the butter is made.

CREAM SEPARATION.

To get them out of the milk is the task of the butter maker; they are too small to be strained out with the finest sieve; fifteen hundred of the largest of them placed side by side, like a row of marbles, would not measure more than one inch. If milk be left at rest, they will rise to the top, because they are lighter than the liquid in which they float. The heavier parts of the milk are drawn down by the force of gravitation, and as the serum of the milk, composed of water, caseine, sugar, albumen, etc., moves downward, it displaces the cream globules and forces them toward the top. There are two methods of separating these fat globules from the milk; a natural method and a mechanical method. In the natural method, the power of gravitation is used to pull the heavier portion of the milk down, with the effect that the lighter part, the fat globules, are pushed upward. In the mechanical method, centrifugal force is applied to attain a like result. When a quantity of milk is put into a rapidly revolving vessel or cylinder, the heavier parts will be forced outward against its resisting side or inner surface with sufficient pressure to push the lighter particles, the globules of fat, toward the center of revolution. In that way the water, caseine, albumen, and the other heavier constituents of milk, find their way to the outside of the quantity being treated in a revolving cylinder, while the globules of fat are collected in concentric form on the inside surface of the quantity being treated. This is the law, that the cream, mainly composed of fat globules, travels in a direction opposite to that of the force exerted upon the milk, whether the force be centrifugal or centripetal.

EFFECT OF TEMPERATURE.

If ordinary milk in a deep-setting pail be left at a temperature of 60° Fahr., it would take these small specks from three to six days to get to the top at the rate at which they would move. They can be helped to move faster. The milk at a temperature between 90° and 98° is slightly enlarged in bulk, and by putting it into deep-setting pails at a higher temperature (90° to 98°), the advantage of a falling temperature from above 90° to 40° or 45° may be gained. That treatment will expedite and facilitate the upward movement of the globules of fat. The rapid cooling of the milk is also believed to prevent the formation of a delicate mesh of lacto-fibrine in the milk, which would hinder the globules from rising freely.

CREAM.

The cream itself is only that part of the milk into which the globules of fat have been gathered in large numbers. Cream has no regular or constant per cent. of fat; the range is from 8 per cent. to 75 per cent. In one hundred pounds of cream there may be only eight pounds of butter, or there may be seventy-five pounds, according to its quality of richness. The globules of fat have no skin or organic coverings distinct in constitution from their own substance. Like drops of quicksilver that have separated from each other, they have no pellicle. But sometimes the serum of the milk becomes so viscous that a quantity of it will adhere to the surface of the globules and, like a coating of gum, will prevent their movement upward when the milk is set, or their movement inward when the milk is treated in a centrifugal machine. If a quart of warm water be stirred into every pailful of milk when it reaches the dairy room from the stable, the separation of the cream will be facilitated. The water may be at a temperature anywhere between 150° and 180° Fahr., and should be warm enough to raise the temperature of the milk to above 90°.

CHURNING.

In the winter season especially difficulty is experienced sometimes in churning the cream. The addition of water at a temperature of 70° to the cream, while it is still sweet, to the extent of 25 per cent. of its bulk, will cause it to yield its butter in less time and more completely. The water should be added before the cream is sour and at least 20 hours before the churning is commenced. The next treatment required is the development of lactic acid. If a quantity of *sweet cream* be churned, and an equal quantity of *sour cream* of the same quality as to composition be also churned, there will be obtained on the average from the sweet cream only 77 pounds of butter out of every possible 100 pounds, while there may be obtained from the sour cream 97 pounds of every possible 100 pounds. There are thousands of pounds of butter lost in the Dominion annually from the churning of two qualities of cream in the same churn at one churning. The only safe plan is to have all the cream for each churning thoroughly mixed from twelve to twenty hours before the operation begins. It should be kept at a temperature of from 60° to 70° Fahr. according to the season of the year, to permit it to become sour. The higher temperature is required during the winter season and for cream from centrifugal separators during the summer season also.

The churning is performed for the purpose of causing the globules of fat to strike on to each other and by impaction to unite. If two globules strike each other at a suitable temperature, they will stick together; when large numbers of them unite in that way, it is said that the butter has "come," and the particles may be washed and removed. All that is required in the churning of cream is that the serum or medium shall be properly treated: (1) by the addition of water if required, as already described; (2) by the development of acid; (3) by the temperature being kept at from 57° to 59° in the summer time or from 62° to 66° in winter. It is imperative that a thermometer should be used to reveal the temperature.

GRANULAR BUTTER.

When the butter particles are half as large as clover seed, 10 per cent. of cold water may be added to the contents of the churn. After they are gathered to be half as large as wheat grains, the churning may be stopped. The buttermilk may be removed and replaced by pure water at a temperature of from 50° to 55° Fahr. It may thus be washed in a granular state. When the water runs off free from a milky appearance, the granular butter should be left in the churn for half an hour to drain.

SALTING.

It may then be salted in the churn or removed to the butter worker for that purpose. Pure salt of fine velvety grain only should be used. The rate of salt-

ing should be regulated to suit the taste and requirements of customers. From three quarters of an ounce to one ounce per pound will be found acceptable to most of those who purchase Canadian butter. The preparation for the market should be made with a view to giving the butter an attractive appearance, whether it be packed in tubs or firkins, or finished in prints or rolls.

At the risk of repeating a little of what has been already presented, I have gathered into paragraphs some further hints and advice, which may be helpful in attaining the end that is being sought, viz., the improvement of butter and the butter trade.

PREPARATION OF MILK FOR CREAMERIES.

1. See that the cows have an abundant supply of good, wholesome feed. Supplement the grass with bran or grain. Corn and pease make firm butter. If grass be dry or scarce, furnish green fodder. The quality of the feed determines to some extent the quality of the fat globules in the milk. Fine butter is mostly composed of these Green fodder is fed with better effect on the quality of the butter after being wilted for a day or two.

2. See that the cows have a liberal supply of pure cold water. As well might a cook expect to make good profitable porridge out of musty oatmeal and stagnant water as to get pure, sweet flavored, wholesome milk out of musty feed and foul drink consumed by a cow.

3. See that the cows have access to salt every day. They know best when to help themselves.

4. Let the cows be saved from annoyance and worry. Any harsh treatment that excites a cow lessens the quantity and injures the quality of her yield.

5. Where practicable let the cows be milked regularly as to time and by the same person.

6. The udders should be well brushed and then rubbed with a coarse towel before milking.

7. All milk should be carefully strained immediately after the milking is completed.

8. Thorough airing of the milk for a few minutes by dipping, pouring or stirring will improve the flavor of the butter.

9. When set for the rising of the cream, milk should be at a temperature above 90° Fahr.

10. When deep-setting pails are used, the water in the tank should be kept below or as near 45° Fahr. as possible.

11. The tank should be shaded from the sun.

12. When a flowing spring is not available, the cooling power of the fresh water may be used more economically if it be carried to the bottom of the tank and the warm water be caused to run off from the top. If water be scarce, the overflow may be carried into a watering trough for the stock of the farm.

13. Milk cans should be washed in cold or tepid water first, and then rinsed in boiling water before they are exposed to be aired. The addition of a little soda and borax to the hot water will increase its cleansing properties.

QUALITIES OF CREAM.

14. Since managers of creameries have adopted the plan of paying for cream according to its butter-making qualities, some dissatisfaction has been caused among the patrons by the differences which comparisons have made evident. In most cases, the trouble arises from an erroneous idea that the richest cream is the best for butter making and the most profitable to the patron. It is not the patron who supplies the cream which yields the greatest number of ounces of butter per inch who always obtains the largest returns from the milk which has been set. Milk which has been set in deep pails at a high temperature, and has not been cooled below 60° Fahr., will yield a cream very rich in butter-making quality; but there will be a smaller quantity of cream obtained from the milk, and a less quantity of butter, than where the milk is cooled as low as 45° Fahr. The longer the time cream stands on milk after practically all of it has come to the top, the less space will it occupy. As it shrinks in bulk it becomes richer per inch, but the total quantity of cream from the milk will not yield any more butter than it would have made before it became compact by long standing. (A creamery inch of cream is equal to 113 cubic inches or to one inch in depth of a cylindrical vessel 12 inches in diameter.) When the milk is skimmed every 12 hours, the cream will not yield as many ounces of butter per inch as when it has been set for 24 hours or longer, but the extra quantity of cream that may be obtained by 12 hours setting in ice water will permit as much of butter to be made from the milk as by setting it for a longer period.

15. Skimming should not be delayed longer that 24 hours after the milk is set. Cream should be removed from the milk before it is sour. Its value to a creamery for butter making depends not alone upon its richness in butter fat; purity, sweetness, and fine flavor are qualities it should possess.

THE OIL TEST CHURN.

16. The oil test churn is used to determine the quantity of churnable fat in each supply of every patron's cream. The requirements for its successful use are:

(*a*) Careful sampling of the cream, which should be poured at least twice from one vessel to another before the sample is taken for the test tube;

(*b*) Accurate measuring;

(*c*) Souring of the cream; (to insure a uniform degree of acidity in all the samples of cream, they should be warmed to 70° Fahr. and kept at that temperature for 24 hours before they are churned);

(*d*) Heating of the samples to a temperature of 135° Fahr. after they have been churned;

(*e*) Subsequent cooling at 65° or 70° Fahr.

(*f*) Churning, reheating, and cooling.

17. In a case where the butter oil on any sample does not separate to show a clear line of demarkation between itself and the other constituents of the cream, the cooling to 70°, the churning and reheating should be repeated.

BUTTER MAKING IN DAIRIES AND CREAMERIES.

18. When shallow open pans are used for setting, the surrounding air should be pure; a damp, musty cellar is no fit place for milk.

19. The cream for each churning should all be gathered into one vessel and kept cool and sweet. A good practice for fall and winter is to mix 25 per cent. of pure water with the cream before it has become sour.

20. The whole of it should be well stirred every time fresh cream is added and half a dozen times a day besides.

21. Two days before the churning is to be done, about one quart of cream for every four pailfuls to be churned—or a quantity equal to two per cent.—should be set apart and kept as warm as 70° Fahr.

22. One day before the churning, that small quantity of cream called a fermentation starter, which will then be sour, should be added to the quantity which is intended for churning and be mixed therewith.

23. It should afterward be kept at a temperature of 60° Fahr.

24. During summer the best churning temperature is 57° or 58°; during late fall and winter 62° to 64° are found to be preferable.

25. The agitation of churning should be kept up till the butter comes into particles larger than clover seed.

26. The buttermilk should then be drawn off and pure water at 55° added in its place.

27. By churning this for a minute or two the butter will be washed free from milk while it is still in a granular state.

28. The milky water may then be drawn off and replaced by a weak brine at the same temperature.

29. After a minute's churning, the butter may be left to drain in the churn for half an hour before it is removed to be pressed and salted.

30. Pure salt of medium fineness and with a body velvety to the touch should be used.

31. Three-quarters of an ounce to the pound will be the right quantity for most markets for immediate consumption, and one ounce to the pound for packed butter.

32. The butter should be kept cool during the working and also during the few hours while it may be left for the salt to dissolve.

33. As soon as the salt is dissolved, the butter may be worked the second time to correct any streakiness which the first mixing of salt may have caused.

34. It should then be put up neatly and tastefully with *as little* crimping and beautifying as feminine fondness for these will permit.

STORE BUTTER.

I venture to add a few hints to the merchants who take butter in trade at stores in towns and villages. I wish to be understood, not as writing anything that will encourage the practice of packing store butter, but as trying to contribute a little to the lessening of the losses which will continue to result from that method of handling it.

ROLL BUTTER.

1. Butter is susceptible to odors or flavors in the surrounding air; it should be kept in a place where the air is pure.

2. If it is to be forwarded to the consumers' market in rolls, it should be handled as little as possible; every handling adds "mussiness" to the appearance and consequently depreciates its value.

3. Each roll should be wrapped in a clean butter cloth, which has been soaked in a strong brine made up from 16 parts of salt and 1 part each of white sugar, saltpeter and borax, dissolved in water.

PACKING BUTTER.

4. Butter which is being collected for packing may be kept in fair condition in a clean box; a better plan is to have it immersed in pure, strong brine.

5. In assorting it, more regard should be paid to similarity of body and flavor than to likeness in the shade of color.

6. The mixing table or butter worker needs to be kept particularly clean; after it has been thoroughly washed with borax water, it should be scalded and then cooled with cold water.

7. The butter should be worked at a temperature which will prevent it from becoming greasy. The temperature at which it is worked or mixed has more effect on the grain and body of the butter than the movements to which it is subjected can have. The cool atmosphere of early morning and a supply of cold water in which to float the butter will meet the needs of the case.

8. Only such packages as have a clean, neat appearance should be used.

9. The top of the butter should be covered with a clean butter cloth, prepared in the same way as that for the wrapping of roll butter.

10. A covering plaster made of wet salt should be put over the cloth, to a thickness of half an inch or more.

11. Butter in tubs and kegs should be brined frequently; the salt covering should not be allowed to become quite dry; a brine similar to that which has been mentioned for use on butter cloths may be used freely with good results.—*From the Bulletin of the Canadian Dairy Commissioner, Experimental Farm, Ottawa.*

THE PHOTOGRAPHIC APPARATUS OF THE GREAT EQUATORIAL OF THE LICK OBSERVATORY.*

By EDWARD S. HOLDEN, LL.D., Director of the Lick Observatory, Foreign Associate.

THE Lick Observatory has just received from the makers of the great telescope the compound slide rest which is to carry the negative plate of the great equatorial. It may be of interest to state the problem which this machine is destined to solve and to briefly describe its arrangements. Accordingly I have asked Mr. Barnard to photograph our photographic appliances (see figure), which he has kindly done.

The problem which was early presented to us in the use of the photographic lens of the great telescope was this:

The tube of the telescope (and very likely the declination axis) is subject to slight flexures, and all long exposures therefore produced short irregular lines instead of round dots for the star images. The focal length of the photographic lens is 47 *ft.* 6 2 in. (aperture 33 in.), and one second of arc is 0·0028 in. on the plate (1′ = 0·166, 1° = 9·948 in.)

So great a focal length makes a very slight *angular* displacement of the image readily visible on the plate as a considerable *linear* distortion.

Hence it was indispensable to provide some means of moving the plate by hand so as to keep the star images fairly round. The first experiments in photography were made by Mr. Burnham in August, 1888, and the pictures of the moon which have hitherto been made here are all by him. During September, 1888, Professor Schaeberle constructed a compound slide rest out of wood, by means of which experiments were made which fully showed that the method proposed would be entirely successful with an apparatus constructed out of metal. About the same time Mr. Common was kind enough to send me photographs of a very similar machine which he had adopted for his great reflector. (See *Monthly Notices*, R.A.S., vol. xlix., p. 297.)

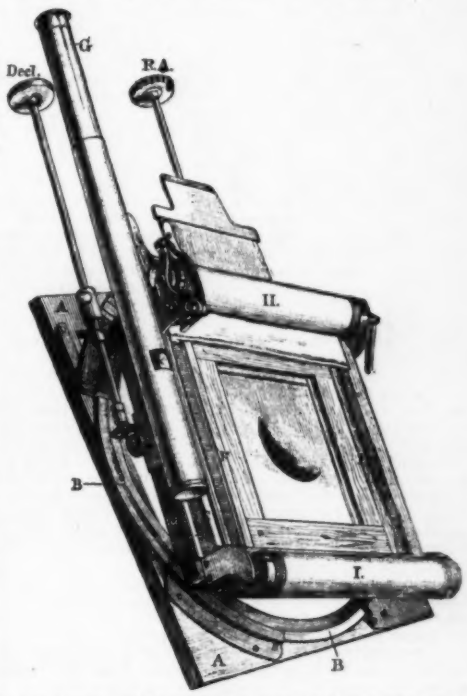
During January and February, 1889, the final plan for our slide rest was settled on, and it has been made by Messrs. Warner & Swasey in a highly satisfactory manner. In a few days it will be in place, and astronomical photography can be resumed here after a long and regrettable interval of lost time.

The general principle of the machine is as follows: The negative plate is mounted on a slide rest, E, movable in right ascension; the slide rest, E, together with the negative plate, is movable in declination on a second slide rest, D. Attached to the right ascension slide rest is a guiding eyepiece, G. The observer directs this eyepiece, which has a reticle plate of glass with wires as below, upon some selected guiding star and

then makes the exposure. As long as the star remains on the proper wire of the reticle, the slides are left unchanged and the negative remains in its original place. As soon as the star leaves the wire, the slides are moved by appropriate handles until the guiding star (and thus the negative) is brought back to its primitive position.

Such then is the general principle of the machine. In the apparatus for the Lick Observatory it was necessary to introduce one more complication, namely, to give the whole machine a rotation of some 40 degrees in its own plane. The focus of the photographic lens is 10 ft. 4·2 in. nearer the object glass than the visual focus. Hence the photographic plate must be reached through a *port* cut in the side of the great tube. (This port is 23 by 12 in.) The most convenient place for such a port is in the side of the tube nearest to the declination axis; but when the telescope was delivered to the astronomers, I found that this port had been cut at random and without consideration in a different place, so that the negative plate when inserted would have its longest dimension inclined some 30 degrees to the parallel. Hence it was convenient to give the plate and the whole apparatus a motion of rotation of 30 degrees in its own plane.

A reference to the cut will make the following description plain: The negative of the moon is on an



COMPOUND SLIDE REST, FOR CARRYING THE NEGATIVE PLATE OF THE 36 INCH EQUATORIAL.

8×10 plate. Hence the scale of the figure is easily determined. The machine was delivered to us beautifully lacquered. It has, however, been ruthlessly painted a dull black.

The lowest square frame of the apparatus I call plate A. This is 23×24¾ in., and in its center is a square hole 19½ in. on a side. When the apparatus is put in place, this plate A is supported by four rods inside the telescope tube and parallel to its axis. A motion along these rods serves to focus the plate. The system of four rods has a thwart adjustment, so that the plate can be made normal to the incident ray. Above the plate A is a circular ring, B, about 23·7 in. outside and 21·5 inside diameter.

This ring is movable in its own plane through about 41° by a handle which is just visible behind the guiding eyepiece. The ring can be clamped in any desired position. Rigidly fastened to ring B is a square

* From the Monthly Notices of the Royal Astronomical Society.

frame, C, 17½ in. outside, containing a square hole 14½ in. on a side. The declination slide, D, is 17½ in. square outside, and also has a hole 14½ in. square cut in its center. This slide can be moved over a distance of about six or seven minutes of arc by a screw of 30 threads to the inch (1 revolution = about 10'). The smooth wooden head to the handle of this screw is seen next the guiding eyepiece. The right ascension slide, E, moves on the declination slide by a similar screw. The roughened handle of this screw is seen above, to the right of the guiding eyepiece.

The right ascension slide contains a hole 12¼×14¼ in. (1° 14'×1° 26'), and this is the largest photographic field available, so that nothing like the whole of the nebula of *Andromeda*, for example, can be photographed at one time. This sacrifice of field was necessary. As the particular advantage of our long-focus lens is to produce negatives suitable for *measures*, this restriction of field is not so regrettable as it might be in another instrument of shorter focus.

Usually a brass box, F, rests inside of E to take the wooden plate holders. This box has a free aperture of 14×12¼ in. When the telescope is not used for photography, the cone of (visual) rays passes through the center of this hole. Two wooden plate holders for 11×14 plates fit directly into the brass box, F.

A wooden carrier, of the right size to be taken by the brass box, F, and containing an 8×10 plate holder, is shown in place, and I have laid in it a negative of the moon taken (in the focus) August 13, 1888. This moon is 5·2 in. in diameter.

Above the whole machine is the exposing apparatus. This consists of two cylinders, I (the lowest in the cut) and II. They are connected by tapes along the edge of the slit. Part of the curtain is rolled on I and part on II in the cut, which shows the disposition of things for a time exposure. The lower roller, I, contains a strong spring. If the thumb piece on the upper roller is touched, the curtain will fly down (in the cut) and cover the aperture. For an instantaneous exposure, the upper roller must be rotated (by the small crank at its end) until the lower curtain covers the aperture. The slide of the plate holder must then be drawn. At the proper time the thumb piece must be touched, when the curtain will fly down, carrying the open part of the curtain past the plate, and quickly covering the plate with that portion of the curtain shown rolled up on the upper roller.

The guiding eyepiece, G, is a positive eyepiece, giving a power of about 500 diameters on the photographic objective. It can be moved bodily in the direction of its length, and clamped in any position. A beam from the objective is received on the prism (near its lower end in the cut) and brought to a focus on its glass reticle, previously described. The wires of this reticle are heavy enough to be seen without illumination. If any light is needed, it can be had by means of luminous paint on the reticle itself.

For enlarging it is necessary to slip a board and tube (not shown in the cut) into the brass box, F, where the negative now is. The brass tube takes all our enlarging lenses. These are about two inches aperture and 14 inches focus, giving direct enlargements near the *visual focus* of seven or eight times. A 4 × 5 double plate holder is used for this purpose.

It will be seen from what goes before that the process of taking a satisfactory negative with the great telescope is not a simple one. Let us suppose that a plate of the Pleiades of two hours' exposure is required. The telescope must be set, the dome turned, the driving clock wound, set in motion, and the control put on. A high step ladder must be moved, so that the observer sitting on its top can look into the guiding eyepiece. The plate is to be inserted and the slide drawn; the whole photographic slide rest must be rotated till the parallel of declination is in the same direction as the edge of the plate, and the curtain must be withdrawn for a time exposure, after a suitable guiding star has been chosen. The observer sits (helpless) on the top of his high ladder, while a second observer must keep the elevating floor at the right level, see that the telescope points fairly centrally through the slit, and watch for the proper times to move the high step ladder, so as to allow the first observer as nearly a comfortable position as is practicable. All this must be done in a dark dome, where only the feebliest red light is permissible.

Exposures longer than two hours can only be made by interruptions for winding up the clock weight (of 600 lb.), which only runs for that period. The difficulties are considerable, and the fatigue and labor are great.

On the other hand, the advantages gained are immense. Photographs of the moon, nebulæ, stars, and planets can be had on a scale of one minute of arc equal $\frac{1.5}{100}$ of an inch. These photographs can be quickly measured on our measuring engine with an accuracy *at least* equal to the best heliometer measures.

I think there is very little doubt that a distance of 3,000" can be measured with an accidental error of not much above one tenth of a second; and hence the photographic determination of parallax should be a comparatively easy matter, provided that constant errors are avoided by taking three or four plates each night.

I have as yet had a limited opportunity to study our negatives.* I find, however, that an eyepiece of one inch equivalent focus can be used with advantage on our best moon negatives. This corresponds to a magnifying power of 570 diameters. That is, it is practicable for an observer to sit in his study and to examine the lunar surface with a magnifying power of 570 diameters as often and as long as he pleases. Even more than this is true. Mr. Barnard has been kind enough to make positive enlargements on glass for me, which show the moon twice as large as in the principal focus.

An eyepiece of one inch equivalent focus is not too high to examine some features of these enlargements (and as they are positives they show the surface in its true light and color). Thus it is practicable to see the lunar surface under excellent definition, and with a power of more than 1,100 diameters, whenever one pleases and as long as one pleases.

I have no hesitation in saying that a study of our moon negatives alone is capable of giving more information regarding the lunar surface than has been obtained by all the laborious years of observation by the most famous observers—Madler, Lohrmann, Schmidt, and others now living.

It is simply necessary to study two sets of negatives, the second being necessary as a control on the first. Lest the above may seem to be too sanguine, I will give one discovery I have lately made on our moon negative of August 14, 1888.

It is well known that Madler (and others) have mapped the walls of the Hyginus rill crossing the floor of the Hyginus crater. The observation is a delicate one, and can only be made when the sun is shining nearly in the direction of the preceding branch of this rill. Although this feature has often been mapped, I think it has seldom been observed.

The walls inside the crater are hardly more than 1,000 to 2,100 yards apart, and their bright tops are not more than 200 to 220 yards wide. Yet I see these walls entirely well in the positive enlargement mentioned.

From this single example it is possible to form a judgment of the results which a competent seleniographer could draw from a suitably selected series of our moon negatives. It is my intention to obtain such series as soon as practicable, and I shall offer a set, in the name of the Lick Observatory, to the Royal Astronomical Society, in the hope that some "lonely and athletic student" may be willing to devote the two or three years necessary to their thorough and exhaustive study.

It is not possible with the force at the disposition of the Lick Observatory to undertake more than the production of the materials for such a study. The study itself must, for the present at least, be left to others.

Lick Observatory, Mount Hamilton, Nov. 23, 1889.

* See, however, a paper by Dr. Elkin in the *Astronomical Journal*, vol. ix., p. 35.

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